FLUKE®

Operator's Manual

Model

5100

Series

Calibrators

P/N 469155

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Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The microprocessor controlled 5100 Series Calibrator outputs are programmable from the front panel or through an optional remote interface, through a wide range of DC voltages and current; AC voltages, current and dBm; and resistance. Connections on the front panel include terminals for output, sense, voltage guard and current guard. A chassis binding post is available on the rear panel. Available on the front panel is a dedicated BNC output connector for use with the Wideband Option -03 which extends the frequency range of the instrument. The connector is installed in all instruments, allowing addition of the option at some later date, if desired.

1-3. The output can be modified using the Front Panel Error Mode controls or through an optional remote interface. This allows the operator, in all outputs except frequency, to modify the output and read the deviation from the base in percentage or digits on the front panel or the remote device. Frequency can be modified to step through the entire range of the meter under test with minimum amount of reprogramming by the operator.

1-4. The 5100 Series has three models of calibrators. The basic model is the 5100A which has all the features listed above. The Model 5101A has all the features of the 5100A plus an integral storage system consisting of a memory and tape cassette which allows the operator to enter or record a program to step the calibrator through a predetermined sequence. The 5102A is electronically identical to the 5100A with the addition of an environmental element-resistant fiberglass case plus all position relays for operation at any angle. This permits safer and easier transport plus the ability to operate in any position.

1-5. Data (Paragraphs, Tables or Figures) pertaining to only a portion of the series, and not the entire series, are marked by following the title of the applicable item with a descriptive notation enclosed in parentheses. Instruments containing a storage memory and tape system, e.g., 5101A, are identified by the notation (Storage Only). Those with the element resistant case, e.g., 5102A, are identified by the notation (Fiberglass Case Only).

1-6. BASIC CALIBRATOR

1-7. Series Common Features

1-8. All models of the Calibrator can provide dc voltage outputs from 0 to 1100 volts on six ranges with resolutions ranging from 0.1 microvolts to 10 millivolts. Direct current outputs are available from 10 microamps to 2 amps on five ranges with resolution between 1 nanoamp and 10 microamps.

1-9. AC voltage outputs between 1 millivolt and 1100 volts are available at 400 hertz. The maximum voltage available varies with the frequency around the 400 hertz base, reaching a 20 volt maximum between 20 and 50 kHz. Six ranges are available for ac voltage outputs with resolution varying from 0.1 microvolt to 10 millivolts. Five alternating current ranges control output from 10 microamps to 2 amps at frequencies of 50 Hz to 1 kHz, with resolution between 1 nanoamp and 10 milliamps.

1-10. Resistance outputs at the cardinal values from 1 ohm to 10 Megohm are available. The outputs from 1 ohm to 10 kilohm have a four terminal measurement capability. The 100 kilohm, 1 Megohm and 10 Megohm outputs use two terminal measurements with the OUTPUT HI and SENSE HI, and the OUTPUT LO and SENSE LO terminals, respectively, connected internally.

1-11. Modification of the output to measure the deviadeviation in a percent of error figure is displayed for each change of the output from the base. The frequency may be altered for AC outputs to cover a range of frequencies; however, there is no percent of error display. The modifications can be programmed from either the Front Panel or a Remote Source.

1-12. Storage System Models

1-13. The storage system consists of a storage memory and a mini-cassette tape system. The storage memory holds up to 61 separate fixed length instructions. Any field not filled when an instruction is created is filled with the default condition; i.e., either the allowable maximum or minimum, as is applicable. Data stored in the memory to form a test program for an instrument, or instruments, may be read out as desired or transferred, through the use of the integral tape system, to a tape for a permanent record. The storage memory may be loaded from a prerecorded tape through the tape system to perform a standard calibration procedure. A program must be loaded into the storage memory to be run, the instrument is not able to operate directly from the prerecorded tape. A printed listing of the program or the data from the step in progress can be obtained from storage system models equipped with an optional Remote Interface and an external printer.

1-14. Element Resistive Models

1-15. The environmental element-resistive case is a fiberglass shell with removable front and rear covers. The case has handles to provide ease of transportation and seals on the case openings to resist entrance of the elements when the case is closed. The covers must be removed to operate the system. The only change in internal circuitry is the substitution of all position relays so that the instrument can be operated while sitting at any angle. Operation of the instrument is identical with the standard instrument.

1-16. OPTIONS

1-17. Analog Options

1-18. The Wideband Option (-03) allows outputs of 300 μV (-57.5 dBm) to 3.1623V rms (+23 dBm) at frequencies from 10 Hz to 10 MHz into a load impedance of 50 ohms. The output impedance is 50 ohms and 50 ohm coaxial cable should be used to transfer the output signal.

1-19. Interface Options

1-20. Two system interface options are available for the 5100 Series. Option -05 interfaces the instrument to the IEEE 488-1975 Bus System. Option -06 interfaces the instrument to a system using a RS232 interface. Only one of the interface options can be installed at a time; however, they are easily exchanged with a minimum of operator training and time.

1-21. SPECIFICATIONS

1-22. Summarized Specifications

1-23. Table 1-1 summarizes the 5100 Series accuracy specifications when they are used in a typical meter calibration service. The tolerances in the table are valid provided the ambient temperature is between 20 degrees and 30 degrees Celsius, the relative humidity is less than 85% and the input line voltage is within 10% of nominal. In addition, they are applicable only when the instrument being calibrated is an analog voltmeter with more than 1000 ohms/volt sensitivities, a TVM or DVM with greater than 1 Megohm input impedance or analog or digital ammeter with less than 1 volt total voltage drop.

1-24. Complete Specifications

1-25. The complete specifications for the 5100 Series Calibrators are listed in Tables 1-2 through 1-7, with each table covering a specific portion of the specifications. Refer to Table 1-2 for detailed listings on DC Volts; Table 1-3 for AC Volts; Table 1-4 for Current, both direct and alternating; Table 1-5 for Resistance; Table 1-6 for the Wideband Option -03; and Table 1-7 for the General Specifications, including environmental information.

Table 1-1. Summarized Specifications

PROGRAMMED OUTPUT	RANGE	ACCURACY +/- (% OF OUTPUT + % OF RANGE + FLOOR)
DC Voltage	All	.005 + .001 + 5 μV
AC Voltage	400 Hz (All ranges) 50 Hz - 1 kHz (Up to 250V) 1 kHz - 10 kHz (Up to 110V)	.05 + .005 + 50 μV
	10 kHz - 20 kHz (Up to 110V) 20 kHz - 50 kHz (Up to 19.9999V)	.08 + .008 + 50 μV
Direct Current	All	.025 + .0025 + .01 μA
Alternating Current	50 Hz - 1 kHz (All ranges)	.07 + .01 + 2 μA
Resistance	Four terminal	
	1 ohm	.02%
	10 ohm	.01%
	100 ohm, 1 kilohm, 10 kilohm	.005%
	Two terminal	
	100 kilohm	.005%
	1 Megohm	.01%
	10 Megohm	.05%

Table 1-2. DC Volts Specifications

DC Volts

Range	Resolution	Maximum Current	Ripple and Noise (10 Hz to 3 kHz) No Load to Maximum Rated Load	Accuracy (6 months) (20°C to 30°C)
±(200V to 1100V)	10 mV	6 mA/400 pF max	<0.05% of setting rms	±(0.005% of setting+0.001% of range+5 μV)
±(20V to 199.999V)	1 mV	10 mA/400 pF max	<0.05% of setting rms (open to 20k Ω) <0.1% of setting rms (20k Ω to max rated load)	
±(2V to 19.9999V)	100 μV	25 mA/1000 pF max	<0.02% of setting +50 μV rms	
±(0.2V to 1.99999V)	10 μV	Limited by 50Ω output resistance	<0.01% of setting +25 μV rms	
±(20 mV to 199.999 mV)	1 μV		<0.01% of setting +25 μV rms	
±(0 to 19.9999 mV)	0.1 μV		<0.01% of setting +25 μV rms	
±(0 to 1.99999V) 50Ω OVERRIDE	100 μV	25 mA/1000 pF max	<0.02% of setting +50 μV rms	

Temperature Coefficient
Above 30°C and Below 20°C add to accuracy limits ±(5 ppm of setting+1 ppm of range+1 μV)/°C. 200V to 1100V range add ±(5 ppm of setting+2 ppm of range)/°C.

Remote Sensing
Four wire remote sensing is available from 2V to 1100V and below 2V in 50Ω DIVIDER OVERRIDE mode. The three lowest ranges are normally internal sensed. Internal sense connections are made automatically inside the box.

Transient Recovery Time
2 Seconds to settle within 50 ppm of final value following any change in output voltage or current for all ranges except 20 to 199.999V, 20k Ω to 2k Ω load and switching between two highest ranges which requires 4 seconds.

Short Term Stability (10 Minutes)
At any fixed temperature from 0°C to 50°C the short term stability is ±(10 ppm of setting+2 ppm of range+5 μV) except above 500V which is ±25 ppm of setting.

Load Regulation
EXTERNAL SENSE: 2V to 1100V±10 ppm no load to full rated load. Same for 0V to 1.99999V using 50Ω DIVIDER OVERRIDE.
INTERNAL SENSE: Same as external except max full load is 400 Ω.

Overcurrent Protection
On all ranges current is limited to prevent damage due to an overload or short circuit at output terminals. The operator is alerted by a flashing "O.L." on the central display. After approximately 2 seconds the calibrator goes to standby.

Guard
The DC voltage section is guarded and a front panel terminal is provided labeled "V GUARD".

Table 1-3. AC Volts Specifications

AC Volts

Range [1]	Resolution	Maximum Current	Frequency	Amplitude Accuracy (6 months) (20°C to 30°C)	Total Harmonic Distortion and Noise
200V to 1100V	10 mV	6 mA/400 pF max	(1 mV to 1100V) 400 Hz	50 Hz to 10 kHz ±(0.05% of setting+0.005% of range+50 μV)	Bandwidth of 10 Hz to 200 kHz. Distortion, line interference + noise including random spikes
20V to 199.999V	1 mV	10 mA/400 pF max	(1 mV to 250V) [3] 50 Hz to 1 kHz		(20V and Higher) 50 Hz to 10 kHz: (0.08% of output) rms
2V to 19.9999V	100 μV	25 mA/400Ω/ 1000 pF max	(1 mV to 110V) 50 Hz to 20 kHz	>10 kHz to 50 kHz ±(0.08% of setting+0.008% of range+50 μV)	(Below 20V) 50 Hz to 10 kHz: (0.05% of output+10 μV) rms
0.2V to 1.99999V	10 μV	2 kΩ/1000 pF max	(Below 20V) 50 Hz to 50 kHz		10 kHz to 50 kHz: (0.08% of output+20 μV) rms
20 mV to 199.999 mV	1 μV	25 mA from 50Ω source resistance	Accuracy: ± 3% Resolution: 1 MSD		
1 mV [2] to 19.9999 mV	0.1 μV				

(1) Can be set in dBm, 0 dBm = 1 mW across 600Ω = .7746V
(2) 10% Lower voltage available using the Edit control
(3) 5.2% Higher voltage available using the Edit control

Temperature Coefficient (Above 30°C and Below 20°C)

AMPLITUDE: Accuracy limits increase by ±(20 ppm of setting+2 ppm of range)/°C
FREQUENCY: Accuracy limits increase by ±0.1%/°C

Remote Sensing

Four wire remote sensing is available from 2V to 1100V. The three lowest ranges are internally sensed. Internal sense connections are made automatically inside the box.

Transient Recovery Time

2 Seconds to settle within 100 ppm for amplitude and within 0.3% for frequency following any change in output voltage, current or frequency. Switching between two highest ranges requires 2.2 seconds.

Short Term Stability (10 Minutes)

At any fixed temperature from 0° C to 50° C the short term stability is ±(0.01% of range+10 μV).

Load Regulation

EXTERNAL SENSE: 0.2V to 1100V ± 200 ppm no load to full rated load.
INTERNAL SENSE: Same as external except voltages less than 0.2V have a load regulation expressed as an output impedance of 50Ω.

The above load regulations are met with reactive loads with power factors between 0.9 and 1.0.

Overcurrent Protection

On all ranges current is limited to prevent damage due to an overload or short circuit at output terminals. The operator is alerted by a flashing "O.L." on the central display. After approximately 2 seconds the calibrator goes to standby.

Guard

The AC voltage function is guarded and a front panel terminal labeled "V GUARD" is provided.

DISCRETE FREQUENCIES AVAILABLE

In Hz	50	60	70	80	90	100	200	300	400	500	600	700	800	900
250V to 1100V									●					
110V to 250V	●	●	●	●	●	●	●	●	●	●	●	●	●	●
20V to 110V	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1 mV to 20V	●	●	●	●	●	●	●	●	●	●	●	●	●	●

In kHz	1	2	3	4	5	6	7	8	9	10	20	30	40	50
110V to 250V	●													
20V to 110V	●	●	●	●	●	●	●	●	●	●	●			
1 mV to 20V	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Table 1-4. Current Specifications

DC Current

Range	Resolution	Compliance Voltage	Accuracy (6 months) (20°C to 30°C)	Ripple and Noise
±(0.2A to 1.99999A)	10 μA	0 to 2.1V min	±(0.025% of setting+0.0025% of range+0.01 μA)	(0.05% of output +0.01 μA) rms
±(20 mA to 199.999 mA)	1 μA	0 to 10V min		
±(2 mA to 19.9999 mA)	100 nA	0 to 10V min	Compliance voltage: >1V add 0.002% setting/volt	Measured with a bandwidth of 10 Hz to 10 kHz including random spikes
±(0.2 mA to 1.99999 mA)	10 nA	0 to 10V min		
±(10 μA[1] to 199.999 μA)	1 nA	0 to 10V min		

(1) 10% lower current available using the Edit Control.

Temperature Coefficient (Above 30°C and Below 20°)

The accuracy limits increase by ±(10 ppm of setting + 2 ppm of range)/°C

Transient Recovery Time

1 Second to settle to within 0.01% of final value following any change in current or compliance voltage.

Short Term Stability (10 Minutes)

At any fixed temperature from 0°C to 50°C the short term stability is ±(50 ppm of setting + 5 ppm of range + 0.002 μA).

Load Regulation

±20 ppm/volt for a change in the output voltage from 1 volt to maximum rated compliance voltage.

Overvoltage Protection

On all ranges voltage is limited to not more than 2V greater than maximum rated compliance voltage due to an open circuit condition. The operator is alerted by a flashing "O.L." on the central display. After approximately 2 seconds the calibrator goes to standby.

Guard

The DC current section is guarded and a front panel terminal labeled "I GUARD" is provided.

AC Current

Range	Resolution	Compliance Voltage	Accuracy (6 months) (20°C to 30°C)	Frequency	Total Harmonic Distortion and Noise
0.2A to 1.99999A	10 μA	0 to 1.4V rms min	±(0.07% of setting +0.01% of range +2 μA)	50 Hz to 1 kHz	Distortion, line interference +noise including random spikes
20 mA to 199.999 mA	1 μA	0 to 7V rms min		Accuracy: ±3%	
2 mA to 19.9999 mA	100 nA	0 to 7V rms min	Compliance voltage: >1V rms add 0.005% of setting/volt	Resolution: 1 MSD	(0.05% of output +2 μA) rms
0.2 mA to 1.99999 mA	10 nA	0 to 7V rms min			
10 μA [1] to 199.999 μA	1 nA	0 to 7V rms min			

(1) 10% lower current available using the Edit Control.

Temperature Coefficient (Above 30°C and Below 20°C)

CURRENT: Accuracy limits increase by ±(25 ppm of setting+10 ppm of range)/°C.
FREQUENCY: Accuracy limits increase by ±0.1%/°C.

Transient Recovery Time

4 Seconds to settle within 0.02% for current and within 0.3% for frequency following any change in output current, voltage or frequency.

Short Term Stability (10 Minutes)

At any fixed temperature from 0° C to 50° C the short term stability is ±(0.014% of setting+0.002% of range+0.4 μA).

Load Regulation

±50 ppm/volt for a change in the output voltage from 1V to maximum rated compliance voltage. Load regulation is met with reactive loads with power factors between 0.9 and 1.0.

Overvoltage Protection

On all ranges voltage is limited to not more than 2V peak greater than maximum rated compliance voltage due to an open circuit condition. The operator is alerted by a flashing "O.L." on the central display. After approximately 2 seconds the calibrator goes to standby.

Guard

The AC current section is guarded and a front panel terminal labeled "I GUARD" is provided.

Table 1-5. Resistance Specifications

Resistance

Range	Power Dissipation	Maximum Current	Peak Voltage	Accuracy (6 months) (20°C to 30°C)	Temperature Coefficient > 30°C and < 20°C Accuracy Limits Increase By	Power Coefficient
1Ω	1W	1A	1V	0.02%	10 ppm/°C	0.1 ppm/mW
10Ω	1W	300 mA	3V	0.01%	10 ppm/°C	0.3 ppm/mW
100Ω	1W	100 mA	10V	0.005%	5 ppm/°C	0.3 ppm/mW
1 kΩ	1W	30 mA	30V	0.005%	5 ppm/°C	0.3 ppm/mW
10 kΩ	1W	10 m/A	100V	0.005%	5 ppm/°C	0.3 ppm/mW
100 kΩ	1W	3 mA	300V	0.005%	5 ppm/°C	0.3 ppm/mW
1 MΩ	100 mW	0.3 mA	300V	0.01%	5 ppm/°C	0.2 ppm/mW
10 MΩ	10 mW	0.03 mA	300V	0.05%	10 ppm/°C up to 40°C 50 ppm/°C above 40°C	0.02 ppm/mW

Two or Four Terminal Ohms Below 100 kΩ
The maximum residual resistance that can be compensated for using the cal 1Ω function is 0.99999Ω

Table 1-6. Wideband Option –03 Specifications

Wideband Option —03

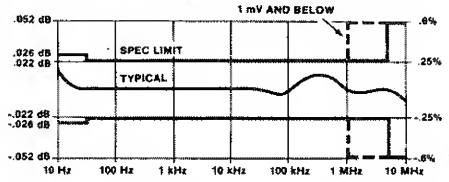
Range Volts	Range Approx dBm[1]	Amplitude Accuracy at 1 kHz Terminated in 50Ω (6 months 20°C to 30°C)	Frequency vs. Amplitude Flatness Terminated with 50Ω and 1 Ft of RG58/AU
1V to 3.1623V	+13 to +23	±(0.25% of setting+0.25% of range)	10 Hz to 30 Hz: ±0.3%
0.31624V to 0.99999V	+3 to +13	±(0.50% of setting+0.25% of range)	> 30 Hz to 1 MHz: ±0.25%
0.1V to 0.31623V	-7 to +3	±(0.75% of setting+0.25% of range)	> 1 MHz to 5 MHz:
31.624 mV to 99.999 mV	-17 to -7	±(1.00% of setting+0.25% of range)	±0.25% above 1 mV
10 mV to 31.623 mV	-27 to -17	±(1.25% of setting+0.25% of range)	±0.6% at 1 mV and lower
3.1624 mV to 9.9999 mV	-37 to -27	±(1.50% of setting+0.25% of range)	> 5 MHz to 10 MHz: ±0.6%
1 mV to 3.1623 mV	-47 to -37	±(1.75% of setting+0.25% of range)	Frequency Resolution:1 MSD
300 μV to 0.99999 mV	-57.5 to -47	±(2.00% of setting+0.25% of range)	Frequency Accuracy: ±3%

(1) 0 dBm = mW across 50Ω = 0.22361V.

Temperature Coefficient (Above 30°C and Below 20°C)
AMPLITUDE: Accuracy limits increase by 0.1 times the accuracies listed in the amplitude accuracy column/°C.
FREQUENCY: Accuracy limits increase by 0.25%/°C.

Transient Recovery Time
2 Seconds to settle within 500 ppm for amplitude and within 0.3% for frequency following any change in voltage, current or frequency.

5100A/5101A WIDEBAND FREQUENCY RESPONSE



Harmonics
-40 dB or lower relative to fundamental for each frequency except -32 dB above 5 MHz.

Spurious Outputs
-50 dB or lower relative to fundamental for each frequency.

Overload Protection
A short circuit on the wideband output will not damage the calibrator. Normal operation is restored upon removal.

Table 1-7. General Specifications

Stability/Environmental
All specifications have been stated with the following conditions:
Time: Six months
Temp: 25°C ±5°C
R.H.: < 85%

Temperature Range
5100A/5101A: Operating 0°C to +50°C
Non Operating -20°C to +65°C
5101A w/tape: Operating +10°C to +40°C
Non Operating +4°C to +50°C

Humidity Range
0°C to 35°C: 85% RH (Non-Condensing)
35°C to 40°C: 70% RH
40°C to 50°C: 50% RH

Shock and Vibration
Meets requirements of MIL-T-28800 for class 5 style E equipment.

Operating Power
(100V to 240V ±10%: 50 - 60 Hz)
5100A: 200 VA Fully Loaded
5101A: 220 VA Fully Loaded

Warmup
30 Minutes to rated accuracy

Dimensions
22.23 cm H x 43.18 cm L x 60.33 cm W
(8.75 in H x 17.00 in L x 23.75 in W)

Weight
5100A: 24.9 kgm (55 lbs) basic
29.5 kgm (65 lbs) fully loaded
5101A: 27.3 kgm (60 lbs) basic
31.8 kgm (70 lbs) fully loaded
5102A: 30.5 kgm (67 lbs) basic
35.0 kgm (77 lbs) fully loaded

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section contains information regarding installation and operation of the Model 5100 Series Calibrators. It is recommended the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, contact your nearest John Fluke Sales Representative, or the John Fluke Mfg. Co., P.O. Box 43210, Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of sales representatives is located in Section 7 of the Instruction Manaual.

2-3. SHIPPING INFORMATION

2-4. The instrument is packed and shipped in a foam-packed cardboard carton. If reshipment is required use the original container or request a new container from the John Fluke Mfg. Co., Inc. Please include the instrument Model number with your request.

2-5. OPTIONS AND ACCESSORIES

2-6. Listed in Table 2-1 are the options and accesories available for the 5100 Series Calibrators. A detailed description of each is included in Section 6 of the Instruction Manual.

2-7. INSTALLATION

2-8. The 5100 instruments are designed for bench-top use (all) or for installation in a standard 19-inch equipment rack (5100A and 5101A) using the optional accessory rack mounting kit. If desired, accessory chassis slides may be installed to facilitate access to the rack-installed equipment. Information on the installation of rack mounting accessories is given in Section 6 of the Instruction Manual.

Table 2-1. Options and Accessories

Option or Model No.	Title
Option –03	Wideband (10 Hz to 10 MHz)
Option –05	IEEE-488-1975 Standard Interface
Option –06	Bit Serial Asynchronous Interface (RS232)
5100A-7003K	Transit Case
5100A-7005K	Extender Accessory Kit
MIS-7190K	Static Controller
MO8-205-600	Rack Mounting Kit
MOO-280-610	Chassis Slides
Y8001	1 Meter IEEE Cable
Y8002	2 Meter IEEE Cable
Y8003	4 Meter IEEE Cable
Y8005*	IEEE Printer
Y8006*	RS232 Printer
Y8007	8-Pack of Minicassettes for Storage System Instruments

**The printing function requires installation of the applicable interface and cable (IEEE or RS232) in addition to the printer applicable for the type of interface in use, and is applicable to storage models only.*

2-9. OPERATING FEATURES

2-10. Front Panel Controls

2-11. The 5100 Series Front Panels are divided into nine major groupings. The groupings and their general use are shown and explained in Figure 2-1 and Table 2-2. The individual groupings are explained and illustrated in greater detail in later paragraphs of this section.

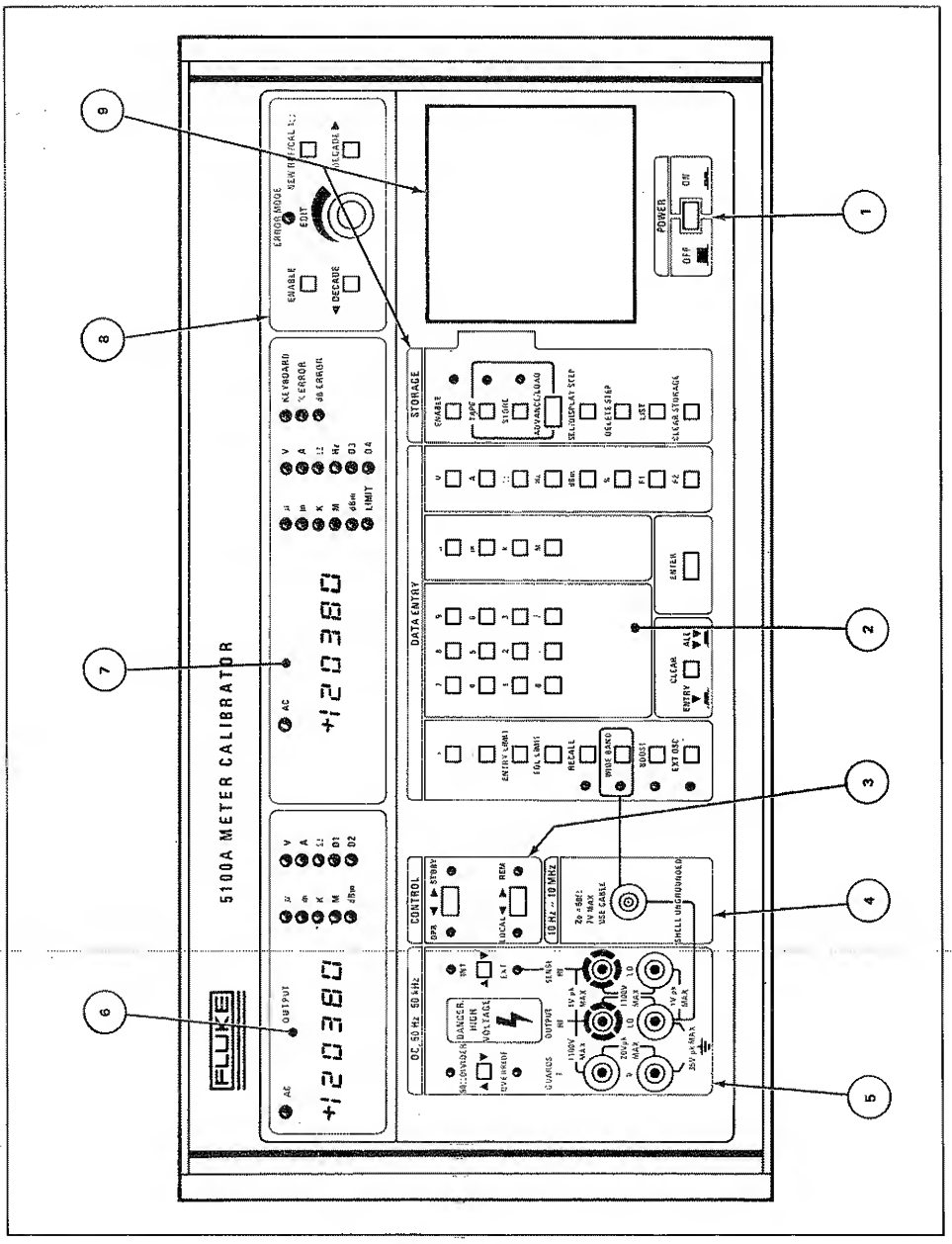


Figure 2-1. Front Panel

Table 2-2. Front Panel Display and Controls

1.	Power	Controls the application and removal of input power.
2.	Data Entry	This portion of the Keyboard allows the operator to enter the data desired into the input registers for display, and upon completion place the data into memory.
3.	Control	Selects the operational status and mode.
4.	Wideband Output	(10 Hz–10 MHz) Output terminal for the wideband frequency option. option. Operational only with Option –03 installed.
5.	Main Output	(DC, 50 Hz–50 kHz) Sense controls and output terminals for the main output.
6.	Output Display	Displays the output value and function.
7.	Central Display	Displays the data entered from the data entry section, the error in a percentage figure, the error in dB's, the output frequency when an AC output is selected and the limits, when recalled.
8.	Error Mode	When enabled, the output may be modified at any decade and the percent of error or dB error deviation from the original figure displayed in percentage or dB respectively.
9.	Storage System (Storage Only)	When enabled, operates the instrument from a stored program. The program may be entered manually or from a previously recorded tape, read by the integral tape system.

2-12. The first eight groupings are identical in operation and positioning for all models in the series. The ninth grouping, the Storage System, is present only in the Model 5101A and any material dealing with it is peculiar to the 5101A only.

2-13. POWER

2-14. The Power Group consists of the POWER switch. The switch is in to apply line power to the instrument and out to remove power.

2-15. DATA ENTRY

2-16. Individual items or groupings on the Data Entry keyboard are explained in Figure 2-2 and Table 2-3. In addition, a voltage (V), dBm entry, WIDEBAND or EXT OSC selection will lock the keyboard from further entries until either the ENTER, RECALL or CLEAR switch is depressed. If either "Err3" or "Err4" result when ENTER is depressed, the original entry is not changed and the KEYBOARD indicator remains illuminated.

2-17. CONTROL

2-18. Switches in the Control Group select the Operating mode (OPR/STDBY) and Controlling device (LOCAL/REM). Both switches are push-push toggle pushbutton switches that illuminate the applicable indicator to show the selected mode. To change from STDBY to OPR depress the switch and the OPR indicator will illuminate and the STDBY indicator extinguish. To return to STDBY depress the switch again and the condition will reverse, i.e., the OPR indicator extinguish and the STDBY indicator illuminate. The LOCAL/REM pushbutton switch operates in the same manner.

2-19. WIDEBAND OUTPUT

2-20. When the Wideband -03 Option is installed and selected, the output is present at the BNC type connector with an output impedance of 50 ohms. The maximum output is 3.1623 Volts rms (+ 23 dBm) into 50 ohms.

2-21. MAIN OUTPUT

2-22. An explanation of the terminals, controls and indicators are given in Figure 2-3 (Page 2-6) and Table 2-4 (Page 2-7).

2-23. OUTPUT DISPLAY

2-24. An explanation of the Output Display and indicators is given in Figure 2-4 (Page 2-6) and Table 2-5 (Page 2-7).

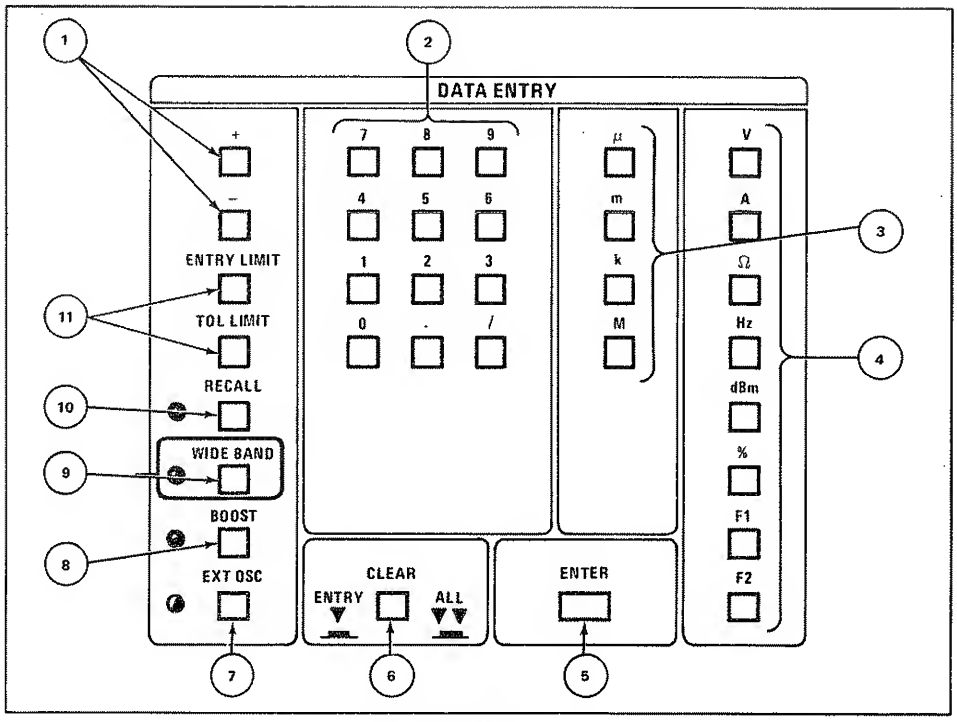


Figure 2-2. Data Entry Group

2-25. CENTRAL DISPLAY

2-26. An explanation of the Central Display and indicators is given in Figure 2-5 and Table 2-6 (Page 2-8).

2-27. ERROR MODE

2-28. An explanation of the Error Mode Controls and indicator are given in Figure 2-6 and Table 2-7 (Page 2-9). The use of any control automatically places the instrument in the Error Mode if it has not been selected previously.

2-29. STORAGE SYSTEM (Storage Only)

2-30. An explanation of the Storage System Controls indicators are given in Figure 2-7 and Table 2-8 (Page 2-10).

2-31. Rear Panel

2-32. The 5100 Series Rear Panel is shown and explained in Figure 2-8 (Page 2-12) and Table 2-9 (Page 2-13) respectively.

2-33. Error Messages

2-34. The Central Display and the optional interface output device will indicate an error by displaying an error code. The codes and errors causing them are shown in Table 2-10 (Page 2-13).

2-35. List (Storage Only)

2-36. The LIST switch in the storage Group allows the Operator to print a hard copy of a stored program or a test in progress, provided the instrument is equipped with one of the optional Remote Interfaces. The instrument must be in the Store Mode, the first desired step of the program selected, and LIST selected to output a listing of the stored program. The printed output starts with the selected program step and continues to the end of the stored program. The output includes the step number; the output (programmed, nominal and full scale as modified by the Error Mode and/or Fractional Scale Operations); tolerance and entry limits; and the status, to include Standby/Operate, Sensing, External position of the Error Mode Digit. The placement of this data in the print format is shown in Figure 2-9 (Page 2-14). Entering any command during a list operation terminates the listing. During a program list the instrument automatically goes to standby.

Table 2-3. Data Entry Group

1.	Polarity	Depress the applicable keyswitch (+ or –) for the desired polarity with any DC Volts or Amps entry. If an entry is not made positive polarity is assumed, if the DC mode is selected.
2.	Numerical	Depress the applicable keyswitch to enter the numerical data desired. Characters available are 0 through 9, the decimal point (.) and the slash (/) used for ratio. Data is entered by depressing the keys in sequence, beginning with the most significant digit. Restrictions are placed on the numerical entries for frequency and resistance. Only the first digit (the MSD) is variable with a frequency entry. Resistance is variable only in decades from 1 ohm through 10 megohms.
3.	Multiplier	Select the multiplier for the numerical data entered. Available are u (10^{-6}), m (10^{-3}), k (10^{3}) and M (10^{6}). No entry assumes a value of units (10^{0}).
4.	Function	Designates the function of the numerical data entered. Depress "V" to select Volts, "A" for Amps, "Ω" for Ohms, "Hz" for Frequency, "dBm" for decibels milliwatt and "%" for percentage. Once Volts, Amps, Ohms, Hertz or dBm have been selected, the instrument is locked into the Keyboard Mode until the data is entered into the instrument with the "ENTER" switch. Switches "F1" and "F2" are not used at this time.
5.	Enter	When the correct entry has been completed (both magnitude and frequency, if applicable) and is shown on the Central Display (frequency only is displayed for AC entries) or Indicators, as applicable, the ENTER switch is depressed to enter the data into memory and perform the selected action. If an Error display results, the data entered in the keyboard memory is retained until correctly entered or cleared.
6.	Clear	Depress the CLEAR switch once to clear the display (CLEAR ENTRY). A second consecutive depression clears memory and resets the instrument (CLEAR-ALL).
7.	External Oscillator	An external input can be used to obtain a desired frequency not available internally. The Source input must be 1.2V +/– 5% and the impedance must be less the 50 ohms. In addition the output frequency must be within the allowable range for the output voltage selected. Only the frequency range is shown on the Central Display, the frequency magnitude is blanked. The function is not active until the ENTER switch is depressed.
8.	Boost	Not used at this time.
9.	Wideband	Selects the Wideband –03 Option with its greater frequency range (10 Hz to 10 MHz) and its dedicated output connector. The function is not active until the ENTER switch is depressed.
10.	Recall	The RECALL switch can be used to restore to the Central Display the stored limit values (output magnitude), voltage (e.g. when the output display reads in dBm), and frequency. The RECALL switch will also clear the keyboard memory and the keyboard indicator.
11.	Limits	Depression of the applicable limit switch enables entry into memory of a limit value, including polarity if applicable for that function. If the polarity is not specified, but is applicable, the entered value is applied as both positive and negative limits. When the polarity is entered the unnamed polarity is unchanged. When programmed data exceeds the ENTRY LIMIT previously entered the entry is refused and the message "Err3" is displayed on the Central Display and the LIMIT indicator illuminated. If the error shown on the Central Display during Error Mode Operations exceeds the figure set with TOL LIMIT the LIMIT indicator illuminates and the Central Display numerics flash. This is for information only, it does not effect the operation of the instrument. The tolerance limit is normally set as a percentage of dB limit. If it is set using any other function, i.e. volts, amps, etc. the value is automatically changed to a percentage of the current output value by the instrument controller.

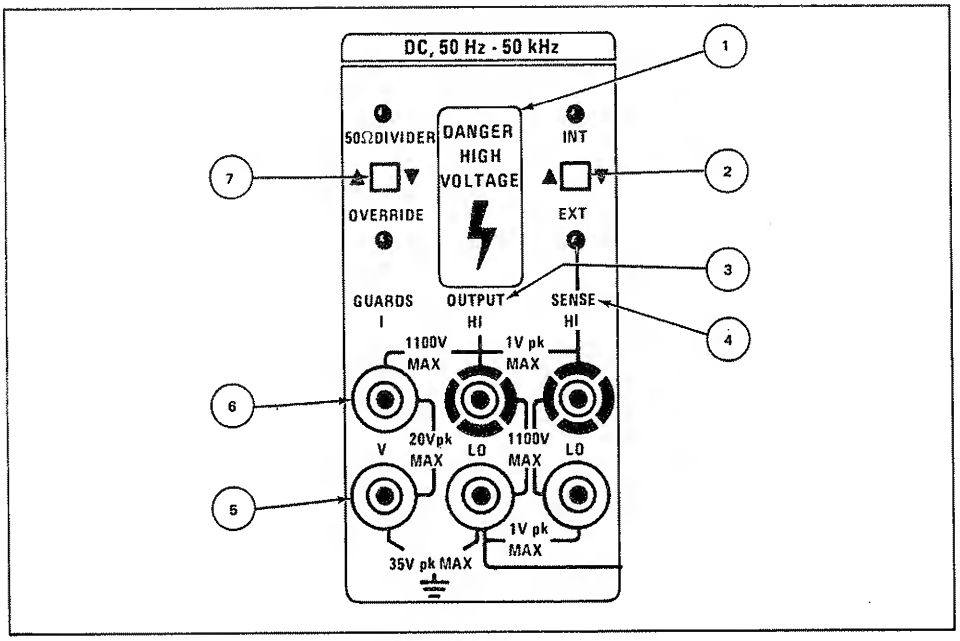


Figure 2-3. Main Output Group

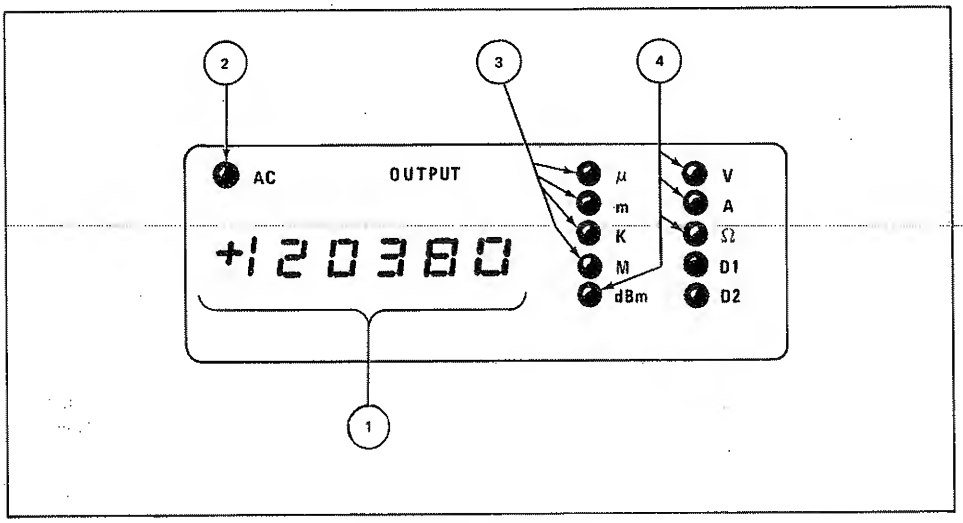


Figure 2-4. Output Display Group

Table 2-4. Main Output Group

1.	Warning Decal	Warning that lethal voltages may be present at the output terminals.
2.	Sense Switch	Push-Push toggle switch to select internal (2-wire) or external (4-wire) sensing. The indicator illuminated signifies the type of sensing selected. To change types depress the switch one time and the indicators will reverse.
3.	Output Terminals	The HI and LO output terminals. All standard Voltage, Current and Resistance outputs are available on these terminals. The maximum difference between the HI and LO terminals is 1100 Volts rms.
4.	Sense Terminals	Used for 4-wire resistance and remote voltage sensing. The allowable difference between Output HI and Sense HI or Output LO and Sense LO is 0.3 Volts.
5.	V Guard	Connects to the inner shield surrounding the analog sections of the 5100A to isolate them from the chassis, I/O connections and digital section. Normally connected to Output Lo at either the Front Panel or the Voltmeter under test.
6.	I Guard	Provides a driven shield "guard" around output HI in the AC and DC Current modes. Held at the same voltage as Output HI by a unity gain amplifier, is used to minimize the degradation of accuracy caused by stray capacitance between Output HI and Output LO. **CAUTION** **Output Current inaccuracies will result if the I—Guard terminal is connected to the V—Guard, Output LO, Chassis or Sense terminal.**
7.	50Ω Divider/ Override	The 50Ω DIVIDER indicator illuminates when an output voltage between 0 and 1.99999 Vdc or between 1 and 199.99 mVac is selected to notify the operator the instrument has automatically changed to an internal precision 50Ω divider. The instrument also automatically reverts to internal sensing, if external had been selected. This divider can be overridden in the dc voltage mode by depressing the switch, which illuminates the OVERRIDE indicator. This holds the instrument in the 20 Volt range, dropping one or more digits; however, external sensing can be selected. If the amplitude of the output is changed while OVERRIDE is selected, the instrument remains in OVERRIDE provided the amplitude stays within the 0 to 1.99999 dc voltage figure. It if exceeds that it automatically reverts to its normal operation, i.e. both indicators extinguished; however, it remains in internal sensing. If external sensing is desired it must be reprogrammed, either manually or through the remote interface.

Table 2-5. Output Display Group

1.	Numeric Display	The absolute numeric value with decimal point and polarity, if applicable, of the signal present at the output terminals.
2.	AC Indicator	Illuminated when the output signal is an AC Voltage of Current.
3.	Multiplier	Indicator illuminates to show the multiplier of the numeric display. The multipliers are u(10^{-6}), m(10^{-3}), k (10^{3}) and M(10^{6}). Units (10^{0}) are the default condition with no indicator illuminated.
4.	Function	Illuminated to show whether the function displayed is Voltage (V), Current (A), Resistance (Ω) or decibel milliwatts (dBm). Indicators D1 and D2 are not used at this time.

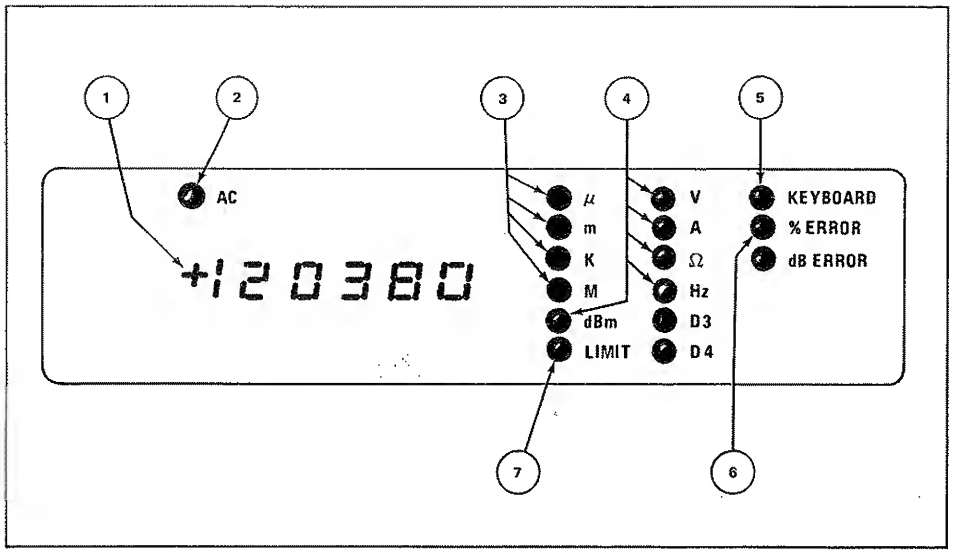


Figure 2-5. Central Display Group

Table 2-6. Central Display Group

1.	Numeric Display	The absolute numeric value and polarity, if applicable, of the signal displayed.
2.	AC Indicator	Illuminated when the displayed signal is an AC Voltage or Current.
3.	Multiplier	Indicator illuminates to show the multiplier of the numeric display. The exponents are u(10^{-6}), m(10^{-3}), k(10^{3}) and M(10^{6}). Units (10^{0}) are the default condition with no indicator illuminated.
4.	Function	Illuminates to show whether the function displayed is Voltage (V), Current (A), Resistance (Ω), Frequency (Hz) or decibel milliwatts (dBm). Indicators D3 and D4 are not used at this time.
5.	Keyboard	Illuminates when a "V", "A", "Ω", dBm, Hz, WIDEBAND or EXT OSC entry is made from the DATA ENTRY group keyboard. Extinguishes when the data is entered into memory.
6.	Error Mode Indicators	When the Output is modified to select the ERROR MODE the applicable indicator illuminates to define whether the displayed numeric is a percentage error or a dB error. The error is the difference between the original output as shown on the output display and the present output display, as modified by the error controls.
7.	Limit Indicator	Illuminates when the displayed error exceeds the tolerance limit stored for that function. The indicator is a warning to the operator only. It does not effect operation of the instrument. The indicator also illuminates when either ENTRY LIMIT or TOL LIMIT is keyed as the initial step in storing a limit value or when the stored limits are recalled for observation.

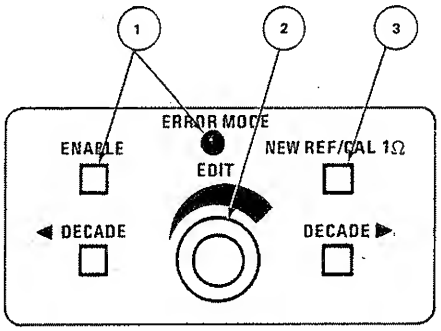


Figure 2-6. Error Mode Group

Table 2-7. Error Mode Group

1.	Enable	The ENABLE switch toggles the instrument into or out of the Error Mode. When in the Error Mode the indicator illuminates. The Error mode cannot be entered if the keyboard indicator is illuminated.
2.	Controls	The edit switch increments the absolute value (clockwise rotation) or decrements the absolute value (counterclockwise rotation) of the intensified digit on the output display (Central Display for Frequency modifications) when the error mode is selected. For example, a clockwise rotation will make a positive number more positive and a negative number more negative. The left decade switch moves the intensified digit one decade to the left (toward the MSD) each time it is depressed. The right decade switches moves the intensified digit one position to the right (toward the LSD) with each depression. Continuing switch depression when the digit has reached one extreme have no further effect.
3.	NEW REF/ CAL 1 ΩHM	Changes the reference used in the computation of %ERROR or dB ERROR to the Value in the Output Display and resets the displayed error to zero. If the instrument is in the fractional scale mode, the full scale reference value is not changed. Used during internal sensed (2-wire) resistance measurements in the 1 ohm range to compensate the display resistance value for residual resistance.

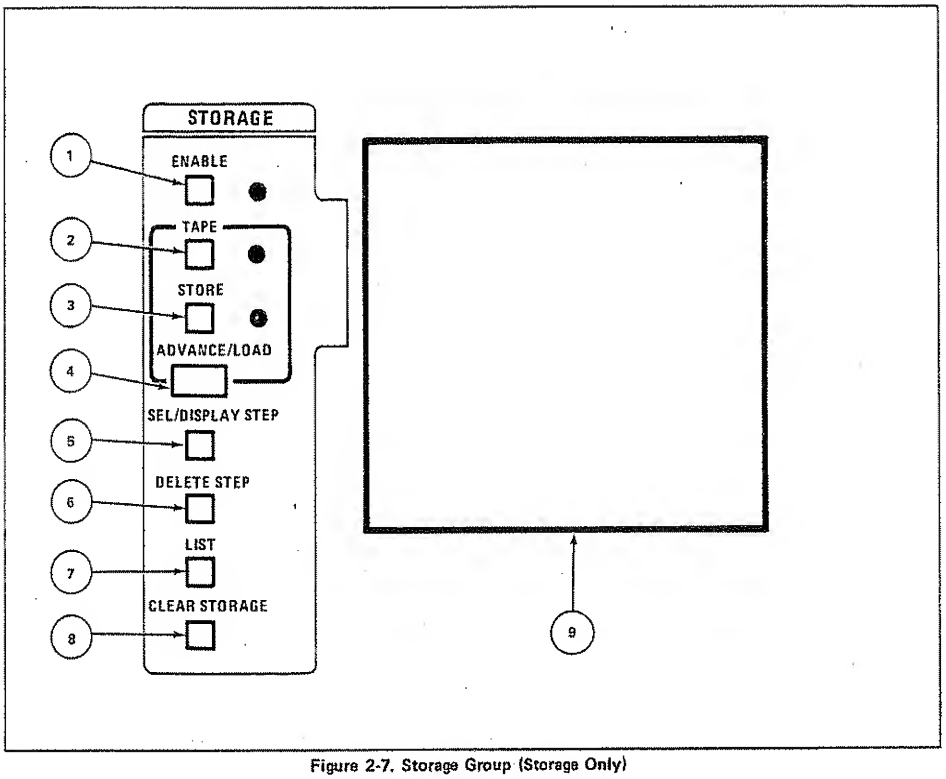


Figure 2-7. Storage Group (Storage Only)

Table 2-8. Storage Group (Storage Only)

1.	ENABLE	The ENABLE switch toggles the instrument into or out of, the storage mode of operation. The ENABLE indicator illuminates with the storage mode selected. Neither the tape system nor the memory can be used until the storage mode is selected.
2.	TAPE	The TAPE switch is a toggle, enabling or disabling the Tape Mode. The TAPE indicator illuminates when the Tape Mode is selected.
3.	STORE	The STORE switch toggles the instrument between the Read and Store Modes. The STORE mode is selected when the indicator is illuminated. When the store mode is selected, data may be transferred from the instrument output to the Storage Memory or from the Storage Memory to Tape. The Read Mode is used to transfer data from a tape to the Storage Memory or from the Storage Memory to the instrument output.

Table 2-8. Storage Group (Storage Only) (cont)

4.	ADVANCE/LOAD	Operation of the ADVANCE/LOAD switch differs for the Read Mode and Store Mode. When the Read Mode is selected and the switch is depressed, the next step in storage is transferred to the instrument output and the step number in increments. When the final step has been selected, "End P" is displayed when the final step is loaded into the last step location. In the Store Mode, when the switch is depressed the output state is transferred to memory at the current step then the step number is incremented. After entering the final step for the capacity of memory, "End P" is displayed. If "FULL" is displayed, the memory buffer capacity would be exceeded and additional commands cannot be accepted.
5.	SEL/DISPLAY STEP	Operation of the SEL/DISPLAY STEP switch is controlled by the operation preceding depression of the switch. If the operation is not preceded by the entry of a numerical value, the step number of the selected step is flashed on the Central Display. If preceded by a numerical entry, the action taken is dependent upon whether the Read or Store Mode is selected, if there is a program entered and whether or not the step selected is within an existing program. When the Read Mode is selected, the step number flashes, then the stored output state is transferred to the instrument output. If the number selected is greater than the last step in the program, "End P" is displayed. In the Store Mode, the number selected is displayed, and that becomes the step referenced in storage operations. If the selected number is greater than the last step in the program the number of the first unused step is displayed and the final step is referenced. In the Store Mode the Output does not change when selecting or displaying steps.
6.	DELETE STEP	The step selected for operation is deleted when the DELETE STEP switch is depressed when the Store Mode is selected. The step numbers of any subsequent steps are automatically decremented so there are no gaps in the sequence. The data replacing the deleted instruction is displayed. "Err 1" is displayed if the DELETE STEP switch is depressed with the Read Mode selected.
7.	LIST	Used with one of the Optional Interfaces to print an 80 column listing of either all or part of the stored program (Store Mode) or the results of an individual test (Read Mode).
8.	CLEAR STORAGE	In the Store Mode all data in the storage memory is deleted and "End P" is displayed when the CLEAR STORAGE switch is depressed. If the switch is depressed in the Read Mode "Err 1" is displayed and no clearing action results.
9.	Tape System	Tape Unit to Read/Store data using a mini-cassette system, providing a permanent record of test programs.

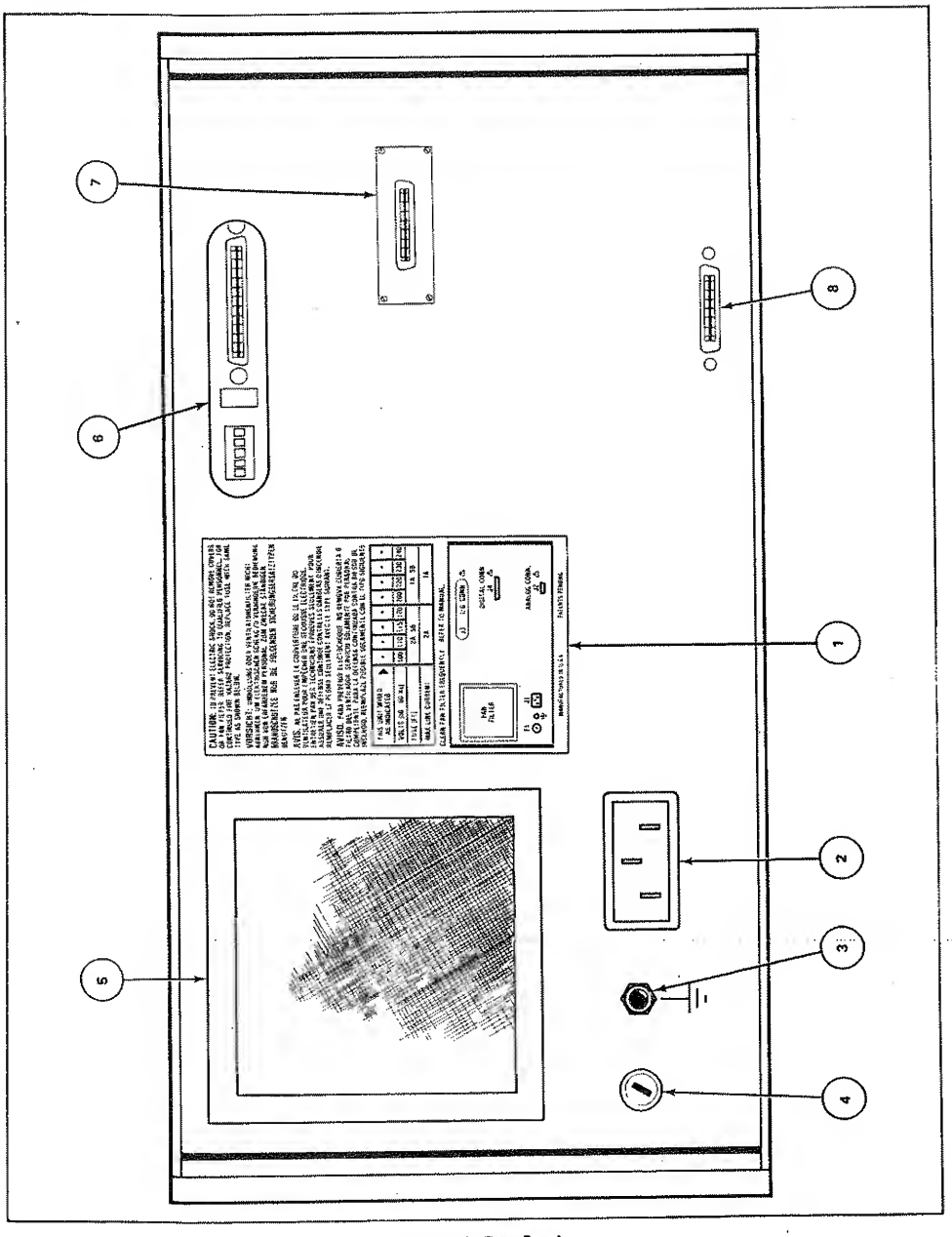


Figure 2-8. Rear Panel

Table 2-9. Rear Panel

1.	Explanatory Decal lists set line voltage and nomenclature and/or identifiers for rear panel items
2.	Input line power connector, J1.
3.	Chassis ground lug.
4.	Line power fuse, F1.
5.	Fan Filter. Refer to Section 4 for maintenance procedure.
6.	Interface Access slot. If one of the optional interfaces is installed in the instrument access to the connector and address controls, if any, will be available here.
7.	MIS Bus Connector. Not used at this time.
8.	Analog Bus Connector. Used at this time only as an input for the External Oscillator Signal, Oscillator Output, and Oscillator Output 90°.

Table 2-10. Error Codes

Err0	No error (status message only)
Err1	Invalid character or sequence
Err2	Invalid frequency or resistance entry
Err3	Programmed output exceeds entry limits or instrument capabilities
Err4	Invalid frequency/output combination
Err5 (Msg) O.L. (display)	Overload or overcompliance voltage.
Err6	Module accessed inoperative or not installed—voltage greater than 20V programmed with high voltage output not installed.
Err7	String command exceeds 32 characters
Err8	Tape load/feed problem or write protected
Err9	Unable to read the tape

2-37. To obtain a listing of the current output select the Read Mode and List. The printed output includes the step number, programmed nominal output, tolerance programmed, the actual output error, and if that exceeds the programmed tolerance, the Word FAIL. The placement of this data in the print format is shown in Figure 2-10.

2-38. Both types of listing are preceded by a heading (see Figures 2-9 and 2-10). A heading may be obtained, subsequent to completion of the current line, by toggling the storage enable switch (two depressions) then depressing the list switch. A heading in progress can be terminated by entering a command.

2-39. All numeric data except the tolerance limits for both List Program and List Data are printed in engineering notation. Only the exponents E-6, E-3, E3 and E6 are printed, the E0 entry is blanked.

2-40. Program Write-Protect (Storage Only)

2-41. Tapes recorded with a program destined for permanent storage may be protected from accidental erasure with the tape cassette write-protect feature. To obtain this feature punch out the cross shaped plug (Figure 2-11) on the top back of the cassette as it is placed in the tape reader. After the plug has been removed an

"Err 8" results if an attempt is made to write additional data, or over the existing data, on that side of the tape cassette.

2-42. LOCAL OPERATION

2-43. Initialization

2-44. The instrument is initialized when power is applied with the power switch, after having been removed, or when the clear switch is depressed twice successively. This clears the registers and memory extinguishing all the indicators except the following: STDBY, LOCAL, INT and 50Ω DIVIDER. In addition the OUTPUT display reads 0.0000 mV and the Central Display flashes the number of the software revision, e.g., 1.0.2. The storage system, if installed, is not cleared by the switch depressions.

2-45. Status During Function Change

2-46. In some cases the instrument automatically drops in status from Operate to Standby when the function is changed. These cases are listed in Table 2-11. When the status changes during a function change depress the OPR/STDBY keyswitch to toggle the instrument back into Operate and continue with the procedure.

2-47. Meter Connection Procedure

2-48. Verify the instrument is in STDBY, then connect the meter to be calibrated to the Output terminals using the applicable configuration from Figure 2-12 (Page 2-17).

HEADING

DATE . . . . . .

INSTRUMENT . . . . . .

. . . . . .

STEP	OUTPUT & REFERENCE	LIMITS	STATUS
1.	2.	3.	4.

1. Program Step Number

2. OUT: Actual Output
   NOM: Programmed Output (nominal)
   FS REF: Full Scale value if the nominal is a fractional scale

3. TOL: Tolerance limits in percent of dB
   ENT: Positive entry limit
   Negative entry limit (printed only if applicable)

4. STDBY or OPR, EXT SENSE or INT SENSE
   EXT OSC or WIDEBAND or 50Ω DIV OVRD (mutually exclusive) and BOOST
   Position of the Error Cursor (1 for Output Display MSD down to 6 for the LSD and FREQ for frequency)

NOTE

If the second entry within a field is not used, subsequent entries within the field fill the vacated space.

Figure 2-9. LIST Program (Storage Only)

NOTE

(a.) Some VOM's have a non-linear input impedance; i.e., a meter with 10 kΩ/volt input impedance might have the positive half cycle at 10 kΩ/V and the negative half cycle at 5 kΩ/V or the positive at 10 kΩ/V and the negative at 20 kΩ/V, resulting in measurement inaccuracies. This type of VOM can be calibrated by either using the optional wideband output (up to 3.1623V) or by connecting a resistor in parallel with the VOM input (across the 5100 Series output terminals). Use the following formula to compute the resistance value, then select the next higher standard resistor value.

RC = EP/IL where:

RC = Computed Resistance

EP = Programmed Calibrator output

IL = Maximum Load current for programmed callbrator range (see specifications)

(b.) Wideband AC Voltmeters (bandwidths exceeding 1 MHz) are susceptable to high-frequency noise on the low ranges and should be calibrated at levels below 10 mV using the Wideband (10 Hz - 10 MHz) Output (Option-03).

2-49. DC Voltage Output

2-50. Obtain a DC Voltage output using the following procedure:

1. If the meter being tested is not connected perform the connection procedure above.
2. Select the desired polarity and depress the applicable keyswitch.
3. Visible on the Central Display is the correct polarity.

NOTE

If a polarity is not selected, during DC operations, the instrument defaults to a positive polarity when the command is entered into memory.

4. Depress the numerical keyswitches required to obtain the absolute value of the desired voltage. Select in the normal sequence, i.e., from MDS (left) to the LSD (right).
5. The digits appear in the Central Display as they are entered with the LSD added on the right.

INSTRUMENT . . . . . SERIAL NO. . . . . .

DATE . . . . . OPERATOR . . . . . .

STEP	NOMINAL OUTPUT	TOLERANCE	ERROR	
1.	2.	3.	4.	5.

1. Step number of the program (Blank without a program in memory)
2. Nominal Programmed Output
3. Tolerance in Percent or dB
4. Actual Value of Error in Percent or dB
5. Prints **Fail** if the Actual Error Exceeds the Tolerance.

Figure 2-10. LIST Data (Storage Only)

6. Select a multiplier, if required. If none is selected the instrument assumes units.

7. The selected multiplier indicator, if any, illuminates.

8. Depress the V keyswitch to select Volts.

9. The KEYBOARD and V indicators illuminate.

10. Depress the ENTER keyswitch.

11. The data visible on the Central Display transfers to the Output Display, blanking the Central Display.

NOTE

If the programmed output is 2.0 Volts or greater the 50 OHM DIVIDER indicator automatically extinguishes.

12. Select OPR on the instrument, if required.

NOTE

If the current exceeds the capability of the Calibrator the Central Display flashes "O.L." and the instrument goes into STDBY.

13. The DC output may be altered by repeating the procedure starting at step 2.

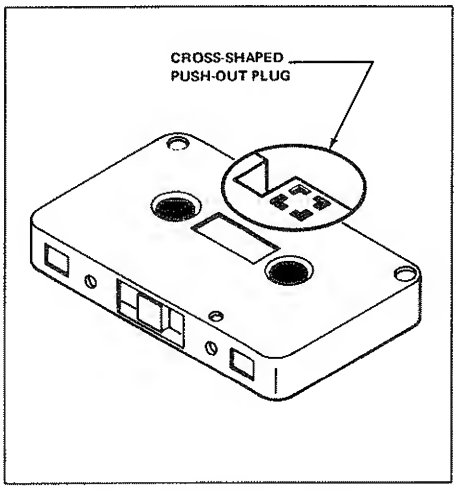


Figure 2-11. Tape Write-Protect Feature

2-51. AC Voltage Output

2-52. Obtain an AC Voltage output using the following procedure:

1. If the meter being tested is not connected perform the connection procedure above.

2. Depress the numerical keyswitches required to obtain the absolute value of the desired AC Voltage. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).

3. The digits appear in the Central Display as they are entered, with the LSD being added on the right.

4. Select a multiplier, if required. If none is selected the instrument assumes units.

5. The selected multiplier indicator, if any, illuminates.

6. Depress the "V" keyswitch to select Volts.

7. The KEYBOARD and V indicators illuminate.

NOTE

The output will be a DC voltage until a frequency is entered. The AC voltage may be altered without effecting the frequency by depressing ENTER and deleting the remaining steps of the procedure.

Table 2-11. Standby/Operate Status Change

Present Function	Instrument drops from OPR to STDBY going to the following functions:
<20Vdc	≥20Vdc, ≥20Vac, Adc, Aac, Ohms
≥20Vdc	≥20Vac, Adc, Aac, Ohms
<20Vac	≥20Vdc, ≥Vac, Adc, Aac, Ohms
≥20Vac	≥20Vdc, Adc, Aac, Ohms
Adc	Vdc, Vac, Ohms
Aac	Vdc, Vac, Ohms
Ohms	≥20Vdc, ≥20Vac, <20Vdc, Adc, Aac
Wideband	≥20Vdc, ≥20Vac, Adc, Aac
<20Vdc, <20Vac:	Selected Output is less the 20V
≥20Vdc, ≥20Vac:	Selected Output is equal to or greater than 20V.

8. Depress the numeric keyswitches required to obtain the absolute value of the desired frequency. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).

NOTE

For a frequency entry the MSD is the only allowable significant digit.

9. The frequency entry appears on the Central Display.

10. Select a multiplier, if required. If none is selected the instrument assumes units.

11. The selected multiplier indicator, if any, illuminates.

12. Depress the Hz keyswitch.

13. The Central Display AC and Hz indicators illuminate.

14. Depress the ENTER keyswitch.

15. The frequency is displayed on the Central Display and the AC indicator on the Output Display illuminates.

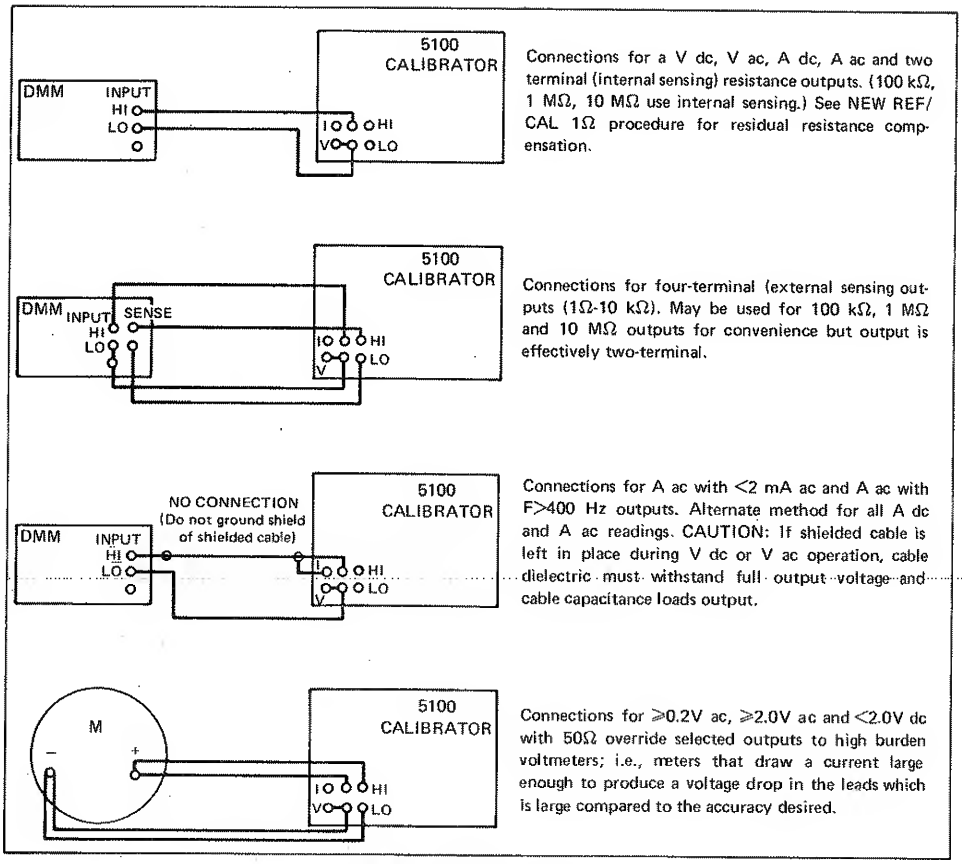


Figure 2-12. Meter Connections

NOTE

The frequency may be altered without entering the voltage into the instrument by deleting steps 1 through 7.

16. Select OPR on the instrument, if required, to obtain an output.

NOTE

If the output current exceeds the capability of the calibrator the Central display flashes "O.L." and the instrument goes into STDBY.

17. Either the voltage or frequency can subsequently be altered without effecting the other.

2-53. Wideband Output

2-54. If the Wideband Option -03 is installed obtain an output at the Wideband Connector using the following procedure:

1. Depress the WIDEBAND switch.
2. The WIDEBAND indicator illuminates.

NOTE

Any voltage and frequency combination, within the specified limits of the Wideband option, previously entered will be available for output. Any limits previously entered are still applicable.

3. Connect a 1 foot RG58/AU cable with BNC connectors between the Wideband output connector and the receiving instrument.

NOTE

Any cable length greater than 1 foot will have an effect on the accuracy specifications. Refer to Section 6 of the Instruction Manual.

4. Select an AC Voltage and Frequency output, if required, as described above.

NOTE

Toggling the WIDEBAND switch and depressing the ENTER switch returns the instrument to standard operation.

2-55. Direct Current Output

2-56. Obtain a Direct Current Output using the following procedure:

1. If the meter being tested is not connected to the instrument output terminals perform the connection procedure above.
2. Select the desired polarity and depress the applicable keyswitch.
3. Visible on the Central Display is the correct polarity.

NOTE

If a polarity is not selected the instrument defaults to a positive polarity when the command is entered into memory.

4. Depress the numerical keyswitches required to obtain the absolute value of the desired DC amps setting. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).
5. The digits appear in the Central Display as they are entered, with the LSD added on the right.
6. Select a multiplier, if required. If none is selected the instrument assumes units.
7. The selected multiplier indicator, if any, illuminates.
8. Depress the A keyswitch to select Current (Amps).
9. The KEYBOARD and A indicators illuminate.
10. Depress the ENTER keyswitch.
11. The command string visible on the Central Display transfers to the output Display, blanking the Central Display. If the 50Ω indicator was illuminated from a prior setting it extinguishes.
12. Select OPR in the instrument, if required, to obtain an output.

NOTE

If the required compliance voltage exceeds the Calibrator's capacity, the Central Display flashes "O.L." and the instrument goes into STDBY.

2-57. Alternating Current Output

2-58. Obtain an Alternating Current Output using the following procedure:

1. If the meter being tested is not connected to the instrument output terminals perform the connection procedure above.
2. Depress the numerical keyswitches required to obtain the absolute value of the desired AC amps setting. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).
3. The digits appear in the Central Display as they are entered, with the LSD added on the right.
4. Select a multiplier, if required. If none is selected the instrument assumes units.
5. The selected multiplier indicator, if any, illuminates.

6. Depress the A keyswitch to select Current (Amps).

7. The KEYBOARD and A indicators illuminate.

NOTE

The output will be in direct current until a frequency is entered. The alternating current may be altered without effecting the frequency by depressing ENTER and deleting the remaining steps of this procedure.

8. Depress the numeric keyswitches required to obtain the absolute value of the desired frequency. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).

NOTE

For a frequency entry the MSD is the only allowable significant digit.

9. The frequency entry appears on the Central Display.

10. Select a multiplier, if required. If none is selected the instrument assumes units.

11. The selected multiplier indicator, if any, illuminates.

12. Depress the Hz keyswitch.

13. The Central Display, KEYBOARD, AC and Hz indicators illuminate.

14. Depress the ENTER keyswitch.

15. The frequency remains on the Central Display and the AC indicator on the Output Display illuminates.

NOTE

The frequency may be selected without entering the current into the instrument by deleting steps 1 through 7.

16. Select OPR on the instrument if required, to obtain an output.

NOTE

If the required compliance voltage exceeds the Calibrator's capacity, the Central Display flashes "O.L." and the instrument goes into STDBY.

2-59. Resistance Output

2-60. Obtain a Resistance Output using the following procedure:

1. If the meter being tested is not connected to the instrument output terminals perform the connection procedure above.

2. Depress the numeric keyswitches required to obtain the absolute value of the desired resistance setting. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).

NOTE

Resistance entries may only be made from 1 ohm through 10 Megohms in multiples of powers of ten (e.g., 10^0, 10^1, 10^2...10^7).

3. The digits selected appear on the Central Display as they are entered.

4. Select a multiplier, if required. If none is selected the instrument assumes units.

5. The selected multiplier indicator, if any, illuminates.

6. Depress the Ω keyswitch to select Resistance (ohms).

7. The OHM indicator illuminates.

NOTE

If a low ohms value (10 Kilohms and below) and internal sensing (two terminal) is selected the Central Display flashes for one-half second "CAL 1Ω" when the ENTER switch is depressed. This display notifies the operator that he may compensate for the residual resistance encountered in low resistance, two-terminal calibration by performing the CAL 1 OHM procedure. This message is only displayed the first time low ohms is selected after initial power applications or a RESET command. The CAL 1Ω display is blanked when the Resistance Value is entered into memory.

8. Depress the ENTER keyswitch.

9. The data visible on the Central Display transfers to the Output Display, blanking the Central Display.

10. Select OPR on the instrument, if required, to obtain an output.

2-61. dBm Output (AC Volts only)

2-62. Obtain an output in decibels (i.e., 0 dBm is equal to 1 mW across 600 ohms for the main output terminals or across 50 ohms for the Wideband Option output.) using the following procedure:

1. If the meter being tested is not connected to the instrument output terminals perform the connection procedure above.

2. Obtain an AC Output using the procedure above.

NOTE

The dBm entry below can be substituted for AC volts when obtaining an output.

3. Depress the numeric keyswitches required to enter the value of the desired dBm setting. Select in the normal sequence, i.e., from the MDS (left) to the LSD (right).

4. The frequency on the Central Display is blanked and the digits appear on the Central Display as they are entered, with the LSD added on the right.

5. Depress the dBm keyswitch.

6. The KEYBOARD and dBm indicators illuminate.

7. Depress the ENTER keyswitch.

8. The dBm value selected transfers to the Output Display and the frequency reappears on the Central Display.

NOTE

To determine the dBm output level in voltage, depress RECALL, V, ENTER and the value will be displayed on the Central display. Depress RECALL to toggle the instrument out of the Recall Mode.

2-63. Enter Entry Limit

2-64. Place an Entry Limit in memory using the following procedure:

1. Depress the ENTRY LIMIT keyswitch.

2. The LIMIT indicator illuminates.

NOTE

Entry Limits may be set in either volts or amps at any value; however, the instrument will not exceed the values listed in the specifications. If a polarity is not assigned the entry will be both positive and negative limits. If a polarity is specified the other polarity remains unspecified until an entry is made.

3. Select the polarity, if desired, and depress the applicable keyswitch.

4. Visible on the Central Display is the correct polarity.

5. Depress the numeric keyswitches required to obtain the absolute value of the desired entry limits. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).

6. The digits appear on the Central Display as they are entered, with the LSD added on the right.

7. Select a multiplier, if required. If none is selected the instrument assumes units.

8. Select either Volts (V) or Amps (A).

9. The applicable indicator illuminates.

NOTE

The value of the Entry Limit is stored at this time; however, it is not compared against an existing value until the ENTER switch is depressed.

10. A value higher than the Entry Limit in memory cannot be entered until the Entry Limit is changed or cleared. Any attempt results in an Err3 display, which has no effect on the existing output. The value stored can be verified by using the Recall procedure described in a subsequent paragraph. In addition, if an entry limit is entered that is smaller than the programmed output Err3 results. The error signal can be cleared by reprogramming the entry limit or the output, or by resetting (depressing CLEAR twice successively) the instrument.

2-65. Tolerance Limit Entry

2-66. Place the Tolerance Limit in memory using the following procedure:

1. Depress the TOL LIMIT keyswitch.

2. The LIMIT indicator illuminates.

3. Depress the numerical keyswitches required to obtain the absolute value of the limit percentage. Select in the normal sequence, i.e., from the MSD (left) to the LSD (right).

4. The digits appear on the Central Display as they are entered, with the LSD added on the right.

5. Depress the % keyswitch.

6. The % ERROR indicator illuminates.

NOTE

The tolerance limit is now entered into memory; however, it is not compared against an existing value until the Error Mode is entered. A percent of error greater than the entry during Error Mode operations causes the LIMIT indicator to illuminate and the numeric value on the Central Display to flash. This is a notice to the operator that the preset error limit has been exceeded. It does not effect the operation of the instrument.

2-67. Error Mode Operation

2-68. The Error Mode is used to find the deviation from a previously obtained output. This output may be in Volts (dc or ac), Amps (dc or ac), Ohms, Hertz or decibels.

2-69. The Error Mode is entered by activating any of the rotary or keyswitches in the Error Mode Group. The Central Display immediately blanks any data displayed and substitutes zero error if the EDIT switch is rotated, if the NEW REF/CAL I OHM keyswitch is toggled, or if the ENABLE, ◀ DECADE or DECADE ▶ keyswitches are toggled (if cursor right decade is depressed to enter the Error Mode the frequency is displayed). If an internal calculation overflow results from exceeding the instrument's calculating ability or from a tolerance limit entry the Central Display will show "L Err" for large error. The data blanked from the Central Display is placed in temporary storage and redisplayed with the return to the normal mode. The instrument can be returned to the normal mode of operation by toggling the ENABLE keyswitch or by depressing any Front Panel keyswitch except the remaining Error Mode Group or OPR/STDBY.

2-70. VOLTS/AMPS ERROR MODE OPERATION

2-71. With the Volts/Amps measurements the output signal is altered until the meter under test reads correctly. Therefore as the output magnitude goes higher it shows that a larger change is required to bring the test meter to the correct display and the percent of error is negative. The change in magnitude of the output is the inverse polarity of the percent of error.

2-72. Check the Volts/Amps Error Mode operation using the following procedure:

1. If the meter being tested is not connected to the instrument output terminals perform the connection procedure above.

2. Obtain the desired base output using the applicable preceding procedure.

3. Place the instrument in the Error Mode using the procedure described in the preceding paragraph.

4. With the EDIT switch modify the output until the meter under test reads the base setting of the output.

5. The Output Display reads the output required in volts or amps to obtain the required reading and the Central Display shows the difference from the base as a percentage.

2-73. OHMS ERROR MODE OPERATION

2-74. For an Ohms error the Output Display is altered to match the reading of the test meter, and as a result, the percentage of error is displayed. In this case the percent increases or decreases with the change from the base and the display polarity has a direct relationship to the change of the output reading.

2-75. Check the Ohms Error Mode operation using the following procedure:

1. If the meter under test is not connected to the instrument Output terminals perform the connection procedure above.

2. Obtain the desired base output using the applicable preceding procedures.

3. Place the instrument in the Error Mode using the procedure previously described.

4. With the EDIT switch modify the Output Display until it corresponds to the reading of the meter under test.

5. The Central Display shows the percent of error in the meter under test.

2-76. FREQUENCY ERROR MODE OPERATION

2-77. The instrument Meter Calibrator does not provide frequency calibration nor does it compute or display frequency errors. However, the error mode does allow the operator to quickly step through the frequency range of the instrument, checking the frequency response of the meter under test.

2-78. Check the frequency Error Mode operations using the following procedure:

1. If meter under test is not connected to the instrument output terminals perform the connection procedure above.

2. Obtain the desired base frequency using the applicable procedure.

3. Depress the DECADE ▶ keyswitch to place the instrument in the Error Mode and move the cursor over the MSD (only digit accessible for modification) of the frequency.

4. With the EDIT switch modify the frequency as desired.

2-79. dBm ERROR MODE OPERATION

2-80. In the dBm Error Mode the displayed error is in dB rather than a percentage. Modification to the base figure is in dBm and the error on the Central Display is changed accordingly.

2-81. Check the dBm Error Mode operation using the following procedure:

1. If the meter under test is not connected to the instrument output terminals perform the connection procedure above.

2. Obtain the desired base output in dBm using the applicable procedure.

3. Place the instrument in the Error Mode using the procedure described above.

4. With the EDIT switch modify the base output until the meter under test reads the desired setting.

5. The Output Display reads the dBm required to obtain the proper reading and the Central Display shows the difference from the base in dB.

2-82. NEW REF/CAL 1Ω Operation

2-83. This switch performs two different functions, dependent upon the status of the instrument. The New Reference function is available any time the instrument is in the Error Mode, while the CAL 1 OHM function requires that 1 ohm resistance be selected also. The sequence of operations for each is given below.

2-84. NEW REFERENCE OPERATION

2-85. If the keyswitch is depressed when the instrument is in the Error Mode the output, as modified by the edit feature of the error mode, becomes the new base except in the fractional scale mode when the full scale reference is not changed. Error mode modifications and percent of error figures will be on the new base established with the NEW REF/CAL 1Ω keyswitch.

2-86. CAL 1Ω OPERATION

2-87. This feature is used to compensate for the residual resistance during two-terminal (internal sensing) operations. Use the following procedure for the CAL 1Ω sequence:

1. Connect the test ohmmeter using the two-terminal method.

2. Select internal sensing and program a 1Ω output from the instrument.

3. Use the error mode and modify the instrument output until it reads the same as the meter under test.

NOTE

The meter under test must be reasonably accurate (+/-%) and must read between 1.00000 and 1.99999 ohms for the CAL 1Ω feature to operate.

4. When the instrument output and the meter under test read the same depress the NEW REF/1 OHM CAL keyswitch.

5. The residual resistance is automatically added to any resistance range selected up to 10 Kilohms as long as the resistance function is selected, it remains on internal sense, and the instrument is not reset, by either removing power or a CLEAR ALL command, or until a new value of residual resistance is entered.

NOTE

If the switch is depressed when the instrument display is greater than 1.99999 ohms, a correction of zero ohms is stored. In addition, the instrument operates as in the NEW REF mode discribed above.

2-88. Fractional Scale Operation

2-89. Fractional Scale Operations allow the operator to output and modify for Error Mode operations some fractional value of the base output while the displayed error is computed on the original value. (Fractional scale entries must be in units; multiplier,i.e., exponents cannot be used.) It is intended for use with a meter under test that has its accuracy at fractional-scale magnitudes specified as a percent of full-scale. When a fractional scale entry

results in a Err3 or Err4 an erroneous output value results from the programmed fraction. Programming a valid output or resetting the instrument will remove the error. The procedure in the following example demonstrates how the percentage of error is computed on a 12 volt base rather than on a 9 volt output obtained with the 3/4 fractional scale entry. The fractional scale feature cannot be used when the instrument is in the Keyboard mode.

1. Obtain an output of 12 volts using the DC volts output.
2. Depress the Data Entry Group keyswitches "3,/,4" to make the fractional scale entry.
3. The Central Display shows "3/4".
4. Depress the ENTER keyswitch.
5. The Central Display blanks and the Output Display is altered to read +9.0000 volts.
6. Rotate the EDIT switch clockwise for an Output Display of +9.0001.
7. The Central Display reads –.0008 and the %ERROR indicator is illuminated.

NOTE

A change of .0001 at 9 volts base would read –.0011 (0.0001/9 = –.0011%) while the same change with a 12 volt base would read the –.0008 displayed.

2-90. Entries can be made for any function except dBm or ohms. The entries may also be altered by making a new fractional scale entry. For example: Using the above example if 1/2 was entered the output display would change to 6.0000, 1/4 would change it to 3.000 and 1/1 would change it back to 12.000. As you can see all entries have made their change gased on the original 12 volts, not on the current output. If at some time during the procedure it is desired to change the base to the current output it can be accomplished by depressing the NEW REF/CAL 1 OHM keyswitch. If the ENTER switch is depressed without entering a valid fraction, the instrument drops out of the fractional scale mode.

2-91. External Oscillator Operation

2-92. Desired frequencies that are outside the capability of the instrument, i.e., more than one significant digit or more accurate, can be obtained using the External Oscillator feature. The external frequency must be within the range of the standard 5100 Series (50 Hz to 50 kHz) at 1.2V rms +/–5% and an output impedance no greater than 50 ohms. The signal is input to the instrument at pins 4 (EXT OSC) and 7 (OSC COM) of J2, the Analog Connector on the Rear Panel. Instruments with serial numbers less than 855000 will have pin 14 as OSC COM.

2-93. Certain limitations are placed on external frequency/programmed voltage combinations when maximum performance is required. These limits are listed in Table 2-12. Other combinations may be programmed, at the user's discretion; however, the performance will be degraded and the instrument may go into Overload ("O.L."). No damage will result to the instrument from the overload condition.

NOTE

Amplitude instabilities, distortion, noise, etc., of the external oscillator can appear at the instrument output.

Table 2-12. External Frequency/Voltage Limitations

External Frequency	Programmed AC Voltage
50 Hz – 350 Hz	250V
>350 Hz – 450 Hz	1100V
>450 Hz – 1 kHz	250V
>1 kHz – 20 kHz	110V
>20 kHz – 50 kHz	19.9999V

2-94. Operate with the external oscillator using the following procedure:

1. Connect the external oscillator signal to J2 on the Rear Panel, insuring it is within the frequency, voltage and impedance limits as stated above.
2. Depress the EXT OSC keyswitch to select the External Oscillator function.
3. The KEYBOARD and EXT OSC indicators illuminate.
4. Program the desired output voltage or current.
5. Program a frequency within one of the brackets in Table 2-13 to match the input frequency.
6. Depress the ENTER switch.
7. The programmed voltage and frequency are displayed and the KEYBOARD indicator extinguishes.
8. Select OPR, if required.

Table 2-13. External Oscillator Frequency Ranges

Output	Input Frequency	Program the Frequency Between
Volts	50Hz to 1999Hz	50Hz to 1000Hz
Volts	2kHz to 20kHz	2kHz to 20kHz
Volts	20kHz to 50kHz	30kHz to 50kHz
Amps	50Hz to 1000Hz	50Hz to 1000Hz

2-95. Recall Operations

2-96. With the instrument toggled into the Recall Mode data stored in memory can be recalled and displayed on the Central Display. The stored values for Voltages (V), Current (A), Frequency (Hz), Resistance (Ω), decibels (dBm), dBm equivalent voltage, Entry Limits or Tolerance Limits in the applicable polarity can be displayed. Depression of an illegal keyswitch toggles the instrument out of the Recall Mode.

2-97. Perform the Recall operations using the following procedure:

1. Toggle the instrument into the Recall mode with the RECALL keyswitch.
2. The RECALL indicator illuminates.
3. If a Limit value (ENTRY LIMIT or TOL LIMIT) is to be recalled depress the applicable keyswitch(s). The appropriate indicator illuminates. The tolerance limit is displayed, if selected.
4. If a polarity is required depress the applicable keyswitch. The polarity indication appears on the Central Display.
5. Depress the keyswitch for the applicable function, i.e., V, A, Hz, etc.
6. The recalled data is displayed on the Central Display with any previously displayed data stored and blanked from the display.
7. Toggling the instrument out of the Recall mode, by depressing the RECALL keyswitch, blanks the recalled data and returns the stored previously displayed data to the Central Display.

NOTE

Depressing RECALL clears the keyboard memory of any data stored and extinguishes the KEYBOARD indicator, if illuminated.

2-98. Storage System Operations (Storage Only)

2-99. The following set of procedures are for the operation of the Storage System and its integral Tape System. In all cases the Storage Mode must be selected by depressing the ENABLE switch so that the ENABLE indicator illuminates. If the Tape System is to be used a tape cassette must be loaded into the Tape System.

NOTE

Do not attempt to load a tape with any Standard Analog PCB Assemblies removed, except the High Voltage output. The display will blank and the instrument must be reset.

2-100. DISPLAY THE STEP LOCATION

2-100. DISPLAY THE STEP LOCATION SELECTED (STORAGE ONLY)

2-101. Use the following procedure to display the number of the selected step on the Central Display.

1. Depress the SEL/DISPLAY step switch.
2. The number of the step selected flashes on the Central Display, holds for approximately one second, then the display returns to its prior state.

2-102. SELECT A STEP — READ MODE (STORAGE ONLY)

2-103. Use the following procedure to select a predetermined step while in the Read Mode.

1. Verify the Read Mode is selected, i.e., the STORE indicator is extinguished.
2. Select the number of the desired step with the numeric switches in the data entry group.
3. The number entered appears on the Central Display.
4. Depress the SEL/DISPLAY STEP switch.
5. The number of the step selected flashes on the Central Display for approximately one second, then the state stored in that location is transferred to the instrument output. "End P" is displayed if the selected step is beyond the end of the current program.

NOTE

The instrument status might drop from OPR to STDBY with the change in state of the selected output. Refer to Table 2-11 for a list of the operational status requiring a change in status.

2-104. SELECT A STEP — STORE MODE (STORAGE ONLY)

2-105. Use the following procedure to select a predetermined step while in the Store Mode:

1. Select the store mode with the STORE switch.
2. The STORE indicator illuminates.
3. Select the number of the desired step with the numeric switches in the data entry group.
4. The number entered appears on the Central Display.
5. Depress the SEL/DISPLAY STEP switch.
6. The memory moves to the step location selected, provided it is within the existing program. If not, it steps to the first location available for data entry. The selected step number is flashed on the Central Display for approximately one second, then the output returns to its original state.

2-106. READ OUTPUT STATE (STORAGE ONLY)

2-107. Read an output state previously stored in memory using the following procedure:

1. Perform the select a step (Read Mode) procedure previously described, using the number of the step to be read.
2. Depress the ADVANCE/LOAD switch.
3. The state is transferred to the output of the instrument and its appropriate step number is displayed for approximately one second, followed by the display of the output condition.

2-108. STORAGE OUTPUT STATE (STORAGE ONLY)

2-109. Store an output state in memory using the following procedure:

1. Select the store mode with the STORE switch.
2. The STORE indicator illuminates.
3. Verify the state to be stored has been programmed into the instrument.

NOTE

The desired state can be programmed into the instrument at this time or at any time prior to selecting the storage mode of operation.

4. Depress the ADVANCE/LOAD switch.
5. The number of the next step in sequence flashes on the Central Display for approximately one second, then the display returns to its previous state. "End P" is displayed if the step stored fills the memory.

NOTE

"FULL" is displayed when the memory is full and the step cannot be loaded.

2-110. DELETE INSTRUCTION (STORAGE ONLY)

2-111. Use the following procedure to delete a previously entered instruction:

1. Perform the Select a Step (store mode) procedure previously described using the number of the step to be deleted.

NOTE

Instrument must be in the Store Mode.

2. Depress the DELETE switch.
3. The step number deleted flashes on the Central Display for approximately one second. All subsequent steps move up one number and the step moved into the step just deleted is transferred to the output.

2-112. TRANSFER STORAGE MEMORY TO TAPE (STORAGE ONLY)

2-113. Transfer the instructions stored in memory to a tape for a permanent record using the following procedure:

1. Insure a tape cassette is loaded in the Tape Reader then select the Tape Mode with the TAPE switch.
2. The TAPE indicator illuminates.

3. Select the store mode with the STORE switch.

4. The STORE indicator illuminates.

5. Depress the ADVANCE/LOAD switch.

NOTE

If the unit was in OPR (Operate), it will drop in status to STDBY (Standby).

6. The Tape advances.

7. When the transfer of data is complete, the TAPE and STORE indicators automatically extinguish and the tape stops. There is no change in the data displayed or stored in memory except the instrument remains in STDBY.

2-114. TRANSFER TAPE RECORD TO STORAGE MEMORY (STORAGE ONLY)

2-115. Transfer the data stored on a tape to the storage group memory using the following procedure:

1. Insure the tape cassette containing the program to be transfered is loaded in the Tape Reader then select the Tape Mode with the TAPE switch.

2. The TAPE indicator illuminates.

3. Verify the Read Mode is selected, i.e., the STORE indicator is extinguished.

4. Depress the ADVANCE/LOAD switch.

NOTE

If the unit was in OPR it will drop in status to STDBY.

5. The tape advances.

6. When the transfer of data is complete, the TAPE indicator extinguishes automatically, the tape drive stops. Step 1 is transferred to the output, and step "1" flashes on the Central Display, followed by display of the data in Step 1 on the Output Display and the Central Display, if applicable.

2-116. LIST PROGRAM STEPS (STORAGE ONLY)

2-117. Use the following procedure to obtain a permanent printed copy of a program entered into storage memory. An optional remote interface must be installed in the instrument to use this feature.

1. Perform the Select a Step (StoreMode) procedure previously described, using the first number of the desired listing.

2. Depress the LIST switch.

NOTE

If the unit was in OPR it will drop in status to STDBY.

3. The program, or selection portion, is transferred through the optional remote interface to a printing device.

NOTE

The listing is terminated if a front panel switch is depressed or a Command is input through the remote interface.

2-118. LIST DATA (STORAGE ONLY)

2-119. Use the following procedure to obtain a permanent printed copy of the test data. An optional remote interface must be installed in the instrument to use this feature.

1. Verify the Read Mode is selected, i.e., the STORE indicator is extinguished.

2. Depress the LIST switch.

3. The single test step at the output is transferred through the remote interface to the printing device.

2-120. CLEAR STORAGE MEMORY (STORAGE ONLY)

2-121. Use the following procedure to clear the storage memory:

1. Select the store mode with the STORE switch.

2. The STORE indicator illuminates.

3. Depress the CLEAR STORAGE switch.

4. Any data stored in memory is erased and the Central Display flashes "End P" then returns to its prior state.

2-122. REMOTE OPERATION

2-123. The 5100 Series can be remotely programmed through either the IEEE 488-1975 Standard Interface option (-05) or the Bit Serial Asynchronous (RS232)

Interface Option (-06), described in Sections 605 and 606 respectively, of the Instruction Manual. Communication between the controlling device and the instrument interface must be in the standard ASCII codes. The codes accepted by the instrument and a brief explanation of each is given in Table 2-14.

2-124. When one of the optional interface modules is installed in the instrument the Remote Mode can be activated either manually or from the Control Device. The instrument can be placed in remote through the IEEE interface by addressing it with the address assigned to the instrument. Remote can be accomplished through the Bit Serial interface by programming the character "J" as described in later paragraphs. The instrument is put in remote from the front panel by toggling the REMOTE switch. Unless the front panel is disabled or "locked out" by a remote command it can return the instrument to local operation by toggling the REMOTE switch on the front panel.

2-125. Programming instructions may be either initiation or string commands. The initiation commands are one or two character messages that are operated on as soon as they arrive unless they are part of a string, in which case they are executed in sequence within the string. The only exception is reset, which has an immediate response. String commands can be Control Commands, Storage Commands (used with the 5101A only), Data Instructions, Status requests or a combination of the first three, and are sent in a series of one to thirty-two characters that are, with the exceptions noted in the text, concluded with a terminator character.

Table 2-14. Programming Codes

Code	Explanation	Code	Explanation
	INITIATION CHARACTERS		STORAGE COMMANDS (Storage Only)
*	Reset — go to local	Q1	Enable Storage Mode
C	Clear Entry	Q0	Disable Storage Mode
CC	Reset — stay in remote	[1	Enable Tape Mode
LC	Clear entry limits	[0	Disable Tape Mode
TC	Clear tolerance limits	W1	Select Store Mode
I0-3	Interface Interrupt Enable Codes	W0	Select Read Mode
Y0-7	Interface Output Enable Codes	&	Advance/Load
,	Termination Character	(	Select/Display Step
		)	Delete Step
	CONTROL COMMANDS	K	List
		=	Clear Storage
J	Go to Remote - RS232		
#	Go to local — RS232		DATA INSTRUCTIONS
U1	Enable Local Lockout		
U0	Disable Local Lockout	+,–	Polarity entry
S	Go to Standby	0–9	Magnitude entry
N	Go to Operate	.	Decimal point
X1	* Select external sensing	/	Fractional scale entry
X0	* Select internal sensing	E	Exponent entry follows
F1	* Enable external oscillator mode	V	* Volts entry
F0	* Disable external oscillator mode	A	* Amps entry
R1	* Select 50 ohm divider override	Z	* Ohms entry
R0	* Disable 50 ohm divider override	H	* Hertz entry
@	Error Mode toggle	D	* dBm entry
<	Error Mode Cursor one position left	%	Percentage entry
>	Error Mode Cursor one position right		
;	Increment digit under cursor		STATUS
:	Decrement digit under cursor		
$ or '	Store NEW REF/CAL 1 ohm reference	!? or "?	Print Status message
G	Recall (TNR)	?	Print Central Display
L	Enable Entry Limit entry		
T	Enable Tolerance Limit entry		
P1	* Enable Wideband option		
P0	* Disable Wideband option		*Terminator required for action

2-126. Initiation Characters

2-127. RESET "*"

2-128. The instrument is reset to the initial sequence and local mode with this instruction. It assumes the default condition, i.e., all registers reset. The visible effect on the instrument is the STDBY, LOCAL, INT and 50Ω DIVIDER indicators illuminated and the Output Display set to 0.0000 mV dc. In addition the Wideband, External Oscillator, Echo Capability and Line Feed Suppression features are disabled and the IEEE Service Request disabled.

NOTE

Allow a 500 ms interval between a Reset command "" and any subsequent command.*

2-129. CLEAR "C"

2-130. A Single "C" entry during a numeric entry while in the keyboard mode clears that entry. A second successive "C" entry clears the instrument to its initial state except it remains in remote. When the "C" is directly preceded by an "L" entry the programmed entry limits are set to their maximum settings. The entry "TC" sets the tolerance limits to maximum tolerance.

2-131. INTERFACE INTERRUPT ENABLE CODES

3-132. Interrupts for the interface system are generated using the alpha character I followed by an octal number between 0 and 3, inclusive. The numeric is based on the three binary bits of an octal number with bit 0 high if the interrupt (Service Request SRQ in the IEEE interface) is enabled with a "Ready" and bit 1 high if enabled with an "Error". "Ready" interrupt refers to a SRQ at the end of a timeout which represents the maximum settling time required in the programmed range. They are generated after a command which causes a change in output, e.g., a terminator or Standby/Operate command. Bit 2 is not used at this time so the available codes extend only to an octal 3. The possible combinations are given in Table 2-15.

Table 2-15. Interface Interrupt Codes

Numeric	Interrupt On Ready	Error
0	Disabled	Disabled
1	Enabled	Disabled
2	Disabled	Enabled
3	Enabled	Enabled

2-133. INTERFACE OUTPUT CODES

2-134. Outputs for the interface system are generated using the alpha character Y followed by an octal numeric between 0 and 7, inclusive. The numeric is based on the three binary bits of an octal number with bit 0 high to suppress alphabetic character output, bit 1 high to enable the echo feature of the RS232 interface and bit 2 high to disable the automtic line feed following a carriage return. The possible combinations are given in Table 2-16.

Table 2-16. Interface Output Codes

Numeric	Alpha Character Output	RS232 Echo Capability	Auto Line feed after carriage return
0	Active	Disabled	Enabled
1	Suppressed	Disabled	Enabled
2	Active	Enabled	Enabled
3	Suppressed	Enabled	Enabled
4	Active	Disabled	Disabled
5	Suppressed	Disabled	Disabled
6	Active	Enabled	Disabled
7	Suppressed	Enabled	Disabled

2-135. TERMINATOR ","

2-136. The character "," (comma) is entered to complete a string of commands and is notice to the controller to execute the preceeding commands back to the previous terminator.

2-137. String Commands

2-138. There are four types of commands that can be used within a string. They consist of entries to program Control Commands, Tape Commands (used with Storage Units only), Data Instructions, or to request a return statement on Status. The Control Commands, Tape Commands and Data Instructions can be combined in a single string, provided the string does not exceed 32 characters in length, including the terminator.

2-139. CONTROL COMMANDS

2-140. Control Commands are used to program the modes of operation. The codes are used to enable or disable the modes of operation. Multiple modes may be enabled in one command string. The Control Commands are given in the following paragraphs.

2-141. Interface Commands

2-142. The IEEE 488-1975 Interface is enabled with an address character which is further defined in the Standard and Section 6 of the Instruction Manual. The RS232

Interface is enabled with the character "J" and disabled and returned to Local control with the character "#". The characters "U1" lock out the LOCAL/REM switch on the Front Panel for a Local Lockout condition, preventing a return to Local from the Front Panel. The Local Lockout is disabled, allowing free use of the front panel with the instruction "U0". The Local/Remote commands are acted on immediately, not requiring a terminator.

2-143. Standby/Operate

2-144. Standby is enabled with the character "S". Operate is enabled with the character "N". The modes are mutually exclusive so the opposite mode is automatically disabled. The Standby/operate commands do not require a terminator for action.

2-145. Sensing

2-146. External sensing is selected with the instruction "X1". Internal sensing with "X0". A terminator is required for execution.

2-147. External Oscillator

2-148. The external oscillator mode is selected with the instruction "F1". To return to the internal oscillator program "F0". A terminator is required for execution.

2-149. 50Ω Divider Override

2-150. The override mode is programmed with the characters "R1". This mode does not allow the instrument to go into DC Voltage ranges below 20 Volts (minimum normal reading 2.0000). An output of 1.99999 or less has a normal output impedance of 50 ohms. The override may be disabled while remaining in the DC Volts with the instruction "R0". Programming a reading above 2.0000V dc, or an output with any function except dc Volts selected automatically disables the override. A terminator is required for execution.

2-151. Error Mode Instructions

2-152. Programming any of the six Error Mode instructions puts the instrument into the Error Mode unless the instrument is in the keyboard mode. The character "@" toggles the instrument, enabling and disabling the Error Mode. The cursor (intensified digit) can be moved to the left by programming "<" or to the right, by ">". The digit under the Cursor is made more positive with the character ";" and made more negative with ":". The character "$" stores the NEW/REF CAL 1 OHM reference. Programming any instruction not legal for the Error Mode (Error Mode Codes, Standby or Operate) while in the Error Mode toggles the instrument out of the Error Mode. The Error Mode instructions do not require a terminator for action.

2-153. Recall

2-154. The instruction "G" (GET) places the instrument in the Recall mode. When in the Recall mode a legal instruction (G, +, –, V, A, H, Z, D, M, T, L, ?) displays the stored data. Any instruction not legal for recall will toggle the instrument out of Recall, if it had been in that mode of operation. Programming Recall M (GM) or Recall followed by a function not selected displays on the Central Display the magnitude of the function selected. The message must be followed by the Central Display Access Instruction (?) to place the data on an output device. The Recall instructions do not require a terminator for action.

2-155. Limits

2-156. The Entry Limit is programmed with the character "L" followed by the applicable magnitude entry. For example, the instruction L12.3456V would enter a limit of +/–12.3456V dc and any entry exceeding that figure would be rejected with an "Err3" display. The instruction "T" followed by the applicable magnitude entry sets the tolerance limits. The typical instruction T.05% would program a limit of 0.05% and any error exceeding that during Error Mode Operation would illuminate the LIMIT indicator and flash the Display, warning the operator the preset limits had been exceeded. Both limit entries may be set to their maximum figure, effectively disabling them, by entering the applicable instruction followed by the character "C" (LC or TC).

2-157. Wideband Option

2-158. When installed, the wideband option is enabled with the instruction "P1". It is disabled with the instruction "P0". When enabled the output is available at the dedicated connector and the applicable voltage and frequency specifications apply. A terminator is required for execution.

2-159. STORAGE COMMANDS (STORAGE ONLY)

2-160. The Storage Commands are only used by instruments in the 5100 Series that are equipped with a Storage System and Tape Drive.

2-161. Storage Enable

2-162. The Storage Mode is enabled with the instruction "Q1" and disabled with "Q0". Until the Storage Mode is enabled with this instruction, the remaining storage commands are ignored.

2-163. Tape System

2-164. Enable the Tape Mode for a Read or Store operation on the tape with the instruction "[1". Disable the Tape Mode with the instruction "[0".

2-165. Store

2-166. Program the instruction "W1" to select the store mode and write data either in the storage memory or on tape. Select the Read Mode with the instruction "W0". This disables the store capability and permits the reading of data from either the storage memory or the tape system.

2-167. Advance/Load

2-168. The instruction "&" performs remotely the functions of the ADVANCE/LOAD switch. The actual function and performance varies with the state of the Tape, Read and Store Modes. With the Tape Mode disabled and the Read Mode selected, the program in the storage memory advances one step. Selecting the store mode with the tape mode remaining disabled results in the programming data being written into the storage location selected and then advancing the program one step. When the tape mode is selected the instruction starts the tape drive motor, which automatically advances until it reaches the end of the program.

2-169. Select/Display Step

2-170. The instruction "(" performs the same function as the Front Panel SEL/DISPLAY switch. The instruction, directly preceded by a numeric entry, displays the data in the program step corresponding to the numeric entry on the Central Display, after flashing the step number. The same instruction without a directly preceding numeric entry results in the flashing display on the Central Display of the current step number.

2-171. Delete Step

2-172. With the store mode selected the instruction ")" causes the program step presently selected to be deleted from the program. Insure the step counter is at the correct position before transmitting this instruction.

2-173. List Instruction

2-174. The instruction "K" lists the present program or the data for the current test as determined by the Read/Store mode status. When the store mode is selected the optional remote interface outputs to a printing device the stored program, starting with the program step selected. In the read mode a list data function results, with the data pertaining to the instruction on the instrument output transmitted through the optional remote interface to a printing device.

2-175. The transmission of any character, including carriage return and/or line feed, after the "K" terminates the output, deleting the listing. Any characters used by the system controller should be suppressed prior to transmission to assure an output of the listing.

2-176. Clear Storage Instruction

2-177. When the store mode has been selected the instruction "=" clears the program previously written in the storage memory.

2-178. DATA INSTRUCTIONS

2-179. The Data Instructions are required to select or change the output from the instrument. They set the polarity, magnitude, multiplier and function of the 5100 Series output. The instructions required for each are listed in the following paragraphs.

2-180. Polarity Instructions

2-181. A positive or negative polarity can be entered with the characters "+" or "-" respectively. A positive polarity is assumed by the instrument if no polarity entry is made.

2-182. Magnitude Instructions

2-183. These instructions include the numberic characters "0" through "9", the decimal point "." and the slash "/" used for the fractional scale divider.

2-184. Multiplier Instructions

2-185. The multiplier for the numeric value is entered into the string using the scientific notation method. The character "E" is programmed followed by the numeric value of the power of ten desired, i.e., for 10^2 program E2, 10^3=E3, 10^4=E4, etc. If there is no entry the instrument assumes units (10^0) for the instruction.

2-186. Function Instruction

2-187. The Function commands define the output selected by the Magnitude commands. The character "V" is programmed to select Volts, "A" for Amps, "Z" for Ohms, "H" for Hertz, "D" for dBm and "%" for percentage.

2-188. STATUS

2-189. Status Messages can withdraw from the instrument and decode information in the status registers and the central display. The displayed data contains both alphabetic and numeric characters, unless the alphabetic characters have been suppressed using the applicable Interface Output Code. The output display is not directly accessible but may be placed on the central display with a recall instruction and then withdrawn with a status request. With any status message, all characters in the message must be accepted by the controlling device before any other operation can be performed by the instrument.

2-190. Status Register Message Instruction "!?" or "?"

2-191. Entry of the characters "!?" results in an immediate response of a nine character message followed by a carriage return and line feed to the interface. A terminator is not required for this control character. Characters 1 and 9 of the message are coded 0 through 9 and characters 2 through 8 are coded 0 through 7. Since some functions or operations are mutually exclusive not all code combinations are used in some characters. The characters, their position and the data provided are given in Table 2-17. When the indicated bit is true the data listed in the Table is present or selected.

2-192. Central Display Access Instruction "?"

2-193. Entry of the character "?" results in the immediate response of a five and a half digit scientific notation number. The first digit will always be a 1 or 0 followed by a decimal point, five digits, "E" for exponent and the exponent sign and digit. The sign of the exponent is transmitted only when it is negative. The sign for the number is transmitted only when it is relevant, i.e., it is not sent for AC amplitudes or frequencies.

Table 2-17. Status Register Message Assingments

No.	Bits 7 - 4	Bit 3	Bit 2	Bit 1	Bit 0	Comments
1	0011	X	X	X	X	Decoded binary number corresponding to the Error Codes in Table 2-9.
2	0011	0	Ready	Overload	High Voltage	**WARNING** **The High Voltage bit is set for DC Voltage above 100 Volts only. It is NOT set for AC outputs.**
3	0011	0	Volts	Amps	Ohms	Only one function may be present at a time.
4	0011	0	dBm	AC	Operate	AC must be selected if dBm is present. Standby present if Operate is not selected.
5	0011	0	50Ω Override	50Ω Divider	External Sense	50Ω Override and 50Ω Divider cannot be selected at the same time. Internal sense present if External Sense not selected.
6	0011	0	External Osc	Boost	Wideband	External Oscillator and Wideband cannot be selected at the same time.
7	0011	0	Recall	Error Mode	Keyboard Mode	Recall and Error Mode cannot be selected at the same time.
8	0011	0	0	0	0	Not used at this time.
9	0011	X	X	X	X	Cursor position. Always 9 if Bit 1 of character 7 False. MSD digit position of Output Display is 0, increasing to 7 at second digit position of Central Display. In Error Mode 9 siginifies off scale to left.

2-194. The numeric message is followed by the character "L" if the LIMIT indicator on the Front Panel is illuminated. A character (Table 2-18) representing any function indicators on the Central Display illuminated follows the numeric portion of the message. When all data has been transmitted the message concludes with a Carriage Return and Line Feed.

Table 2-18. Status Message Function Codes

Character	Indicator illuminated
L	Limit
V	V – Volts
A	A – Amps
Z	Ω – Ohms
H	Hz – Hertz
D	dBm – decibal milliwatts
%	% ERROR
G	dB ERROR

2-195. Only the data on the Central Display is transmitted with the character "?", however, the data can be frequency from an AC operation, a percentage during Error Mode operations or any data available on the Central Display during Recall operations. Examples of each of the above are given in the following paragraphs.

2-196. When the instrument is operating in the AC mode the frequency selected is displayed on the Central Display. If this frequency was 400 Hz and the Central Display was requested with the character "?" the response would be 0.40000E3H CR LF. A frequency of 10 kHz would be transmitted as 1.00000E4H CR LF. Any other frequency would result in status message in the same format.

2-197. In the Error Mode the frequency for editing, the percentage of error calculated and the dB error calculated can be transmitted in a status message, when they are present on the Central Display. If the message is a percentage of error or dB figure and it exceeds the preset tolerance limits so that the LIMIT indicator is illuminated the message ends with the character "L".

2-198. A frequency transmission is transmitted as described above.

2-199. A percentage error is transmitted as shown on the Central Display, i.e., a reading of 0.0031 would be transmitted as 0.0031E0% CR LF.

2-200. In the Recall Mode any data that can be recalled to the Central Display can be transmitted in the status message. This includes programmed values for Volts, Amps, Ohms, dBm, the voltage when dBm is programmed, the tolerance limits and the entry limts, both Voltage and Current.

2-201. Recalled programmed entry limits of +750V dc would be transmitted as +0.75000E3VL CR LF.

2-202. An output of +150 μA dc recalled and transmitted would be +1.50000E-04A CR LF.

2-203. Program Examples

2-204. The following paragraphs contain several programming examples to aid the operator in using the calibrator.

2-205. Use the following instructions to obtain the output listed:

1. +6E-3A, N-In operate with an output of +6 mA dc.
2. 5V1E3H, N-In operate with an output of 5V ac at 1 kHz.
3. L+300VL-250V - Set the entry limits at +300V dc and –250V dc.
4. T.01% - Sets the tolerance limit to ±0.01%
5. 1.5VX1R1, N-In operate with an output of +1.5V dc and the instrument prepared for 4-terminal sensing with the 50 ohm divider overridden.
6. GL+V? - Recall the positive voltage entry limit and output it in a Central Display Access Word.

2-206. The following are some typical status register messages and a decoded explanation.

1. 004210009
   1-No errors
   2-None selected
   3-Volts selected
   4-AC and Standby selected
   5-External sensing selected
   6-None selected
   7-None selected
   8-Not used
   9-Error Mode not used